An overview of the evidence base for the transition minerals strategy

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Abstract

If mining for critical metals is not scaled up, it will likely impact our ability to deliver net zero by 2050.

Due to mining timelines, the mining industry is poorly placed to respond rapidly to the increased demand for metals without technological and social support. However, it is crucial that if we increase mining activity, it does not adversely impact vulnerable communities or cause massive environmental damage.

To increase metal supply in the near future and in a responsible, fair way requires an understanding of the limitations of the permitting landscape (see: Feasibility & Permitting) and three packages of intervention aimed at: innovation (see: Technical Bottlenecks), with a particular focus on reducing the environmental impacts of mining (see: Environmental Issues), and social and community impact and engagement (see: Social Issues).

Written by

Madeleine Luck, PhD
Greg De Temmerman, PhD

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Introduction

Clean energy technologies are key to reducing our reliance on fossil fuels and achieving a net zero economy.[1,2] To achieve the goals of the Paris Agreement and limit global warming to well below 2°C, energy-related greenhouse gas emissions need to fall from around 40 billion tonnes of CO_2 equivalent each year, to near-zero by the middle of this century.[3,4] By scaling up clean energy technologies including wind and solar, electric vehicles, power grids, heat pumps and more, the current fossil-based energy system can be transformed into a net-zero energy system (**Figure 1A-B**).[5,6]

The backbone of a net-zero energy system will be electrification – with much of this power supplied by wind and solar (**Figure 1E**). This clean electricity will be supported by a range of other technologies – two key ones are batteries to store energy (both in electric vehicles, and on the grid), and transmission and distribution grids to shift supply and demand of electricity. Alongside these, heat pumps, electrolysers, and more will also need to be deployed to get to net zero.

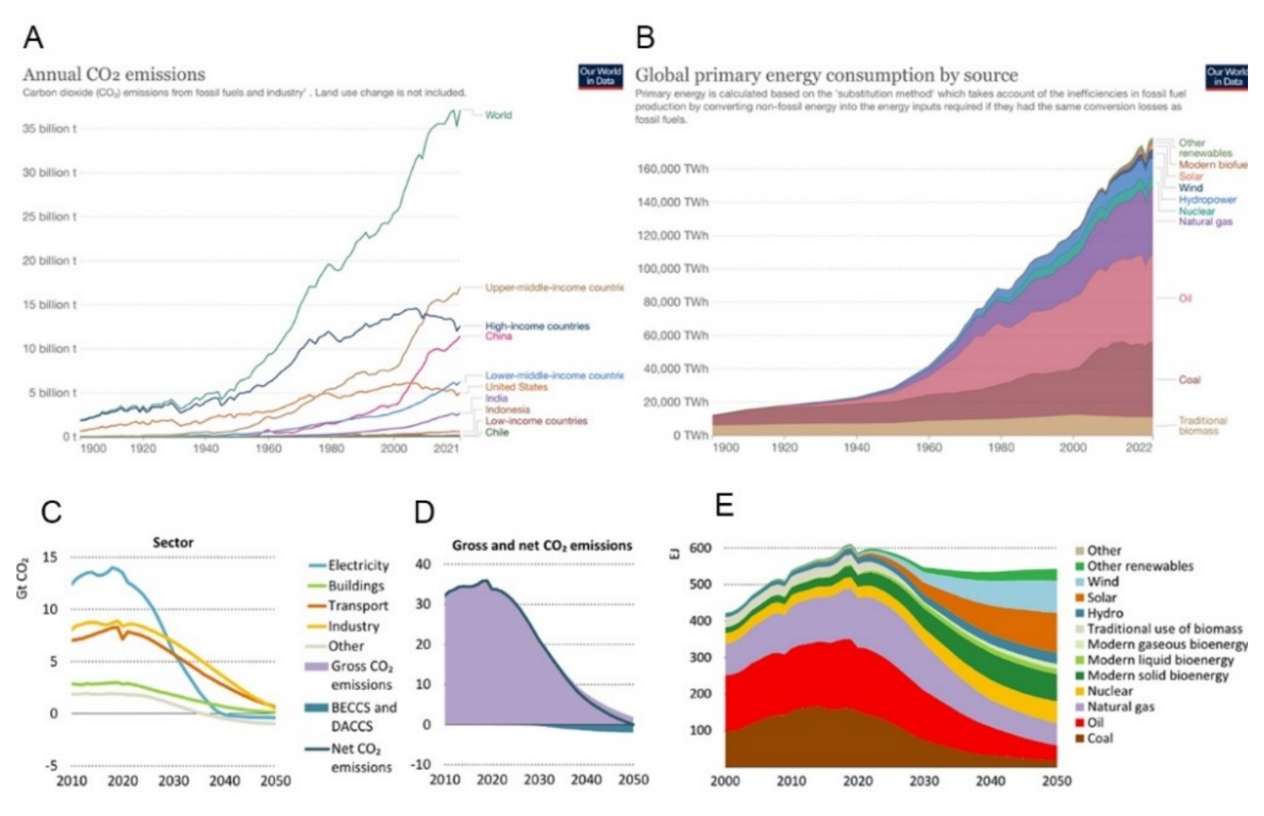

Figure 1. A: Annual global CO_2 emissions showing the worldwide total and some selected countries to illustrate the disparity between the emissions of mineral-producing countries such as Chile and Indonesia, and the demand-driving countries such as the United States. China is an exceptional case in which mineral production and demand are co-located in the same country. This partially contributes to China's high CO_2 emissions (and note that this graph is not normalised per capita). Image from ref 7. CC BY. **B:** Global energy consumption showing a breakdown of total energy mix. Image from ref 6. CC BY. **C:** Of all the major CO_2-emitting industries, the electricity sector has the highest potential for CO_2 emissions reduction and could actually become a net negative CO_2 emitter in the net zero economy scenario shown in **D.** NB: 'Other' = agriculture, fuel production and transformation processing, and direct air capture. BECCS = bioenergy with carbon capture and storage; DACCS = direct air capture with carbon capture and storage. **E:** This graph shows how the energy mix could change to achieve a net zero economy by 2050. Wind and solar power have the highest growth potential. **C-E:** Images from ref 2. CC BY.

All of these clean energy technologies require certain metals when they are manufactured. These are sometimes known as “critical minerals”, which is a definition that varies by country or region.[8-10] There are large uncertainties about the volumes of metal that are required for the energy transition because demand depends on many variables, including the types of technologies deployed in the energy transition, the rate of technology innovation, the prices of metals needed and their potential substitutes, and the strength of climate policy.[11] Modelling energy transition critical mineral demand is very difficult because clean energy innovation sometimes changes in non-obvious ways – for instance, for electric vehicle applications, lithium nickel manganese cobalt oxide (NMC) batteries have a better range due to having a higher energy density than lithium iron phosphate (LFP) batteries. However, due to the concerning existence of child labour in the cobalt value chain (among other things), the market share of NMC batteries has steadily decreased in favour of LFP and other, less cobalt-intensive battery chemistries – a trend that is expected to continue in coming years.[12]

Predictions aside, there are more than enough terrestrial mineral resources to supply the energy transition.[13] Mining for the energy transition is an issue of flux and not of stocks: the challenge is about increasing the production sufficiently fast to follow the pace of the energy system transformation while doing so in a responsible way. This raises multiple challenges. The mining industry works on very long timescales (up to decades), and there are strong environmental and social concerns around local ecosystem and community impacts.[14] However, the overall impact of the energy transition will be to reduce the total amount of mining that happens worldwide. This is because a great deal of mining activity is for fossil fuels (mainly coal).[15] Given that the energy transition will allow for the cessation of continuous fossil fuel mining, and that an increase in critical mineral primary extraction may plausibly be only temporary while the new energy infrastructure is being built, worldwide mining activity should decrease rapidly as the energy transition progresses.[15] Post-transition material needs should partially be met by recycling, so only a fraction of the mining carried out pre-transition will need to continue.[15] Nonetheless, the geographic distribution of mining and its externalities will change. China and India produce the most coal in terms of volume, and Indonesia and the United States also possess many coal mines.[16,17] However, the hotspots for copper, lithium and nickel are Chile (copper, lithium), the DRC (copper), Australia (all) and Indonesia (which extracts 49% of the world’s nickel and has banned the export of nickel ore to boost its value chain capture).[10,18,19] Therefore, if these regions are going to bear the brunt of increased critical mineral mining and processing in the near term, it is essential that the potential for negative environmental and social externalities be minimised.

This report will, where applicable, focus on three high-priority metals for energy transmission and storage: copper, lithium, and nickel (see **Figure 2A**).[13] These metals are all projected to face supply shortages before 2050.[13]

- **Copper** is a clear priority because: its applications are highly cross-cutting; the projected supply/demand deficit is the largest of all the critical minerals in terms of absolute tonnage; its production and processing is highly concentrated in geopolitically tense regions; and its potential for substitution is low-medium. In other words, copper's availability may hold back the energy transition.[20] On the whole, copper production has steadily grown year on year, but a step change is required to fulfil copper demand in the coming decade. In addition, with copper ore grades dropping to below 0.3%, the usual processes for extraction are becoming uneconomic and generating increasing amounts of waste rock.[21] The need for innovation in copper mining has never been more present.

- **Lithium** was selected because it is the material of choice for rechargeable, lightweight, high energy-density battery technologies,[22] and reports are in general agreement that lithium production will need to increase steeply to supply demand between now and 2050, especially if solid state batteries are adopted.[23] Most lithium mining or extraction is carried out in regions of water stress, so it is important that lithium extraction is scaled up with safeguards in place.[18]

- **Nickel** is also used to make batteries; the most popular battery chemistry in 2022 was lithium nickel manganese cobalt oxide (NMC, with a market share of 60%). The third most popular battery chemistry was nickel cobalt aluminium oxide (NCA, with market share of 8%).[22] However, it is important to note that due to concerns about the supply of cobalt, automakers (who are the main drivers of battery demand) are turning towards lithium iron phosphate (LFP) battery chemistries, which have already captured 30% of the battery market share.[22] There are therefore large uncertainties in nickel demand estimates, which places nickel-producing countries (most notably Indonesia, where nickel production and processing is a large economic driver) in a precarious situation. However, aside from batteries, nickel could be required for a variety of other clean energy technologies such as wind turbines and electrolysers.[13]

As cobalt is often co-produced with some of these metals and has similar use-cases, this metal may be considered alongside the others but is not a priority for action because of the rapid evolution of battery chemistries. This is partly due to suppliers wanting or needing to move away from cobalt, and the supply-demand gap is relatively small (**Figure 2B**).[24,25] Please note that this report will not cover non-metals such as graphite and silicon, nor will it consider the use of deep sea mining because there is no evidence to suggest the technique will be economically or environmentally viable.

Increasing the supply of these critical minerals in the short term is no easy feat because:

- **i.** taking a mine from prospect to operation takes many years, and;
- **ii.** there is social opposition to mining due to the associated environmental, social and governance (ESG) risks.[25]

Therefore, the aim of the rest of this review is to highlight challenges and opportunity areas that could be leveraged to **increase critical metal supply in a responsible and just manner**.

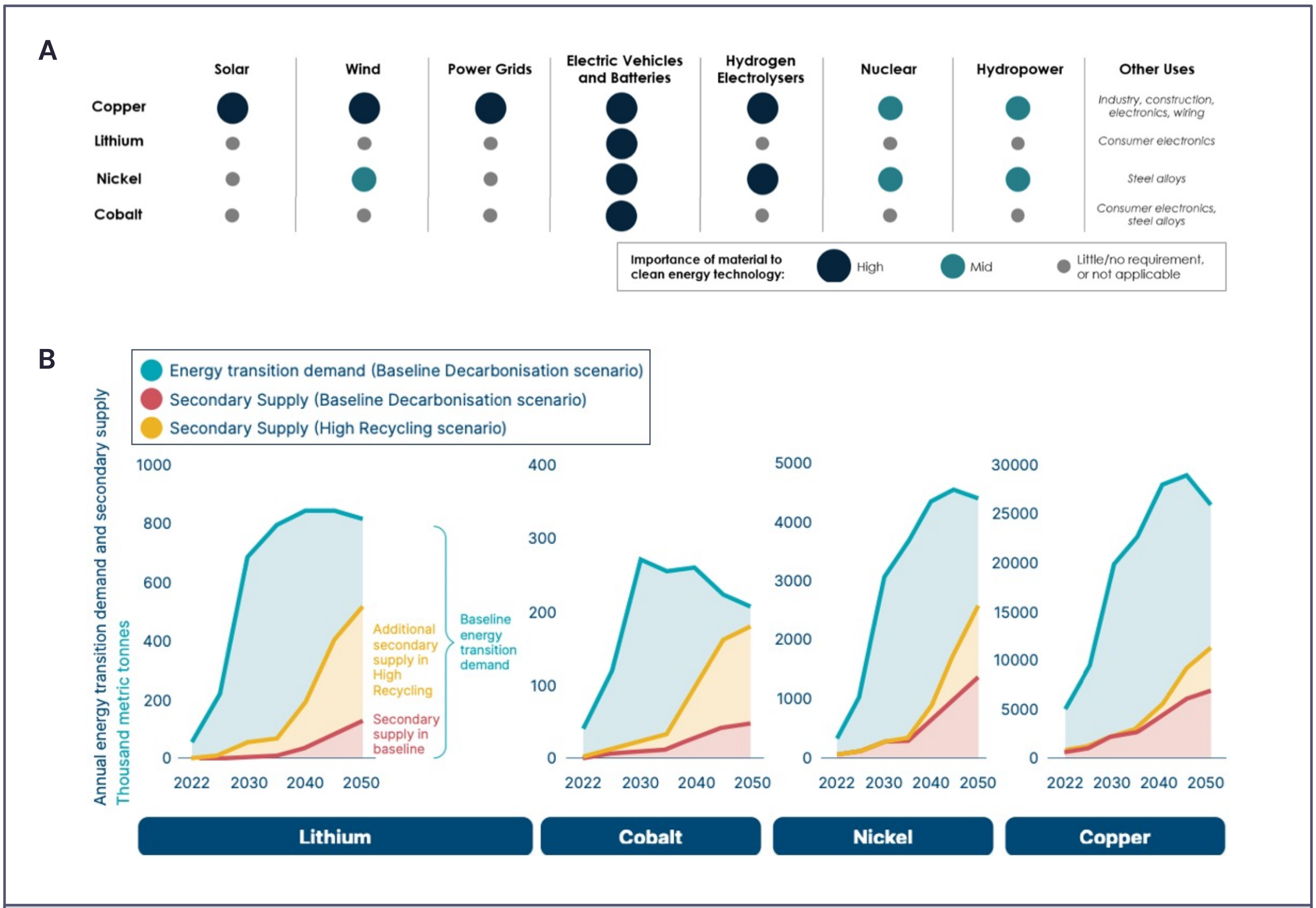

Figure 2. A: Illustration showing the use-cases and relative importance of the chosen metals to chosen energy transition technologies. Note that this graphic contains 'nuclear', referring to nuclear fission, which is not technically a renewable technology. **B:** Projections showing energy transition demand of selected critical minerals (blue line), and how much of the demand can be met by recycling scenarios (amber and red). All graphs point to the need for increased resource extraction in the near term, balanced with a contraction in the longer term. Note the y axes are different. Images from ref 13.

The mining industry

Critical minerals are essential for the energy transition, but the mining industry is poorly equipped to respond quickly (within the next five to 10 years) to increasing demand. The issues facing miners are multifactorial and non-trivial. To avoid metal supply holding up the energy transition or even negating any environmental benefits from the switch to renewables, some crucial constraints for metal supply need to be addressed.[26] Below, we will explore these issues systematically.

Feasibility & permitting

Mining projects take decades to evolve from prospect to plan, and plan to project. This significant time delay represents a risk to investors called the "valley of death" (or, in mining terminology, the orphan period of the Lassonde Curve – see **Figure 3**).[27] The valley of death refers to the post-discovery, pre-feasibility stage of a mine in which speculative investors have sold out, and institutional investors are yet to buy in. Many projects do not survive the valley of death (hence its name), because a deposit may become uneconomical to mine during the pre-feasibility period due to its geological properties, extraction and processing costs, location, market price or even the discovery of a 'better' deposit.[28] In addition, permitting can take many years and cost in excess of $50M. Mine developers are rewarded for these large upfront costs throughout the mine's lifetime, which is typically 50-60 years. This explains why the mining industry is not interested in scaling up metal supply for the short term; mines have long life cycles, and it is not profitable to open a mine site only for it to close after around 20 years.

Feasibility studies (see the 8-12 year region of the Lassonde Curve, **Figure 3**) are notoriously underpowered because mining companies have not embraced new techniques to account for the fact that ore deposits are less accessible and have more complex mineralogy than was the case previously.[29] A 2019 McKinsey survey of over 40 mining projects from 2009-2019 showed that 63% of projects were disasters (i.e., 15-100% over budget), with a third of those projects being corporate disasters (i.e., more than 100% over budget).[29] Better feasibility studies (perhaps combined with land valuations or nature-based assessments) would help to ensure that mining operations are not unnecessarily abandoned, and save the mining industry over $100bn that could be better spent on decarbonising the industry.[29,30]

Permitting is a bottleneck, and since stringent permitting requirements are correlated with advanced mining economies (i.e., those that have relatively good ESG scores), we should not aim to water down permitting requirements to accelerate the energy transition. Broadly, the issue seems to be a lack of capacity and expertise within the relevant governmental agencies to deal with permits in an expedient manner. However, there is one area in which changing licensing and permitting could actually be beneficial to society, and that is for the repurposing of mining waste. In Australia alone, there may be an estimated five million tons of copper in tailings waste.[31] The revalorisation, remediation and stabilisation of mining waste would increase critical metal supplies while benefitting human health and environmental wellbeing.[32,33] Unfortunately, the global number and contents of mining waste pits or reservoirs (also known as tailings storage facilities, TSFs) is not known.[34]

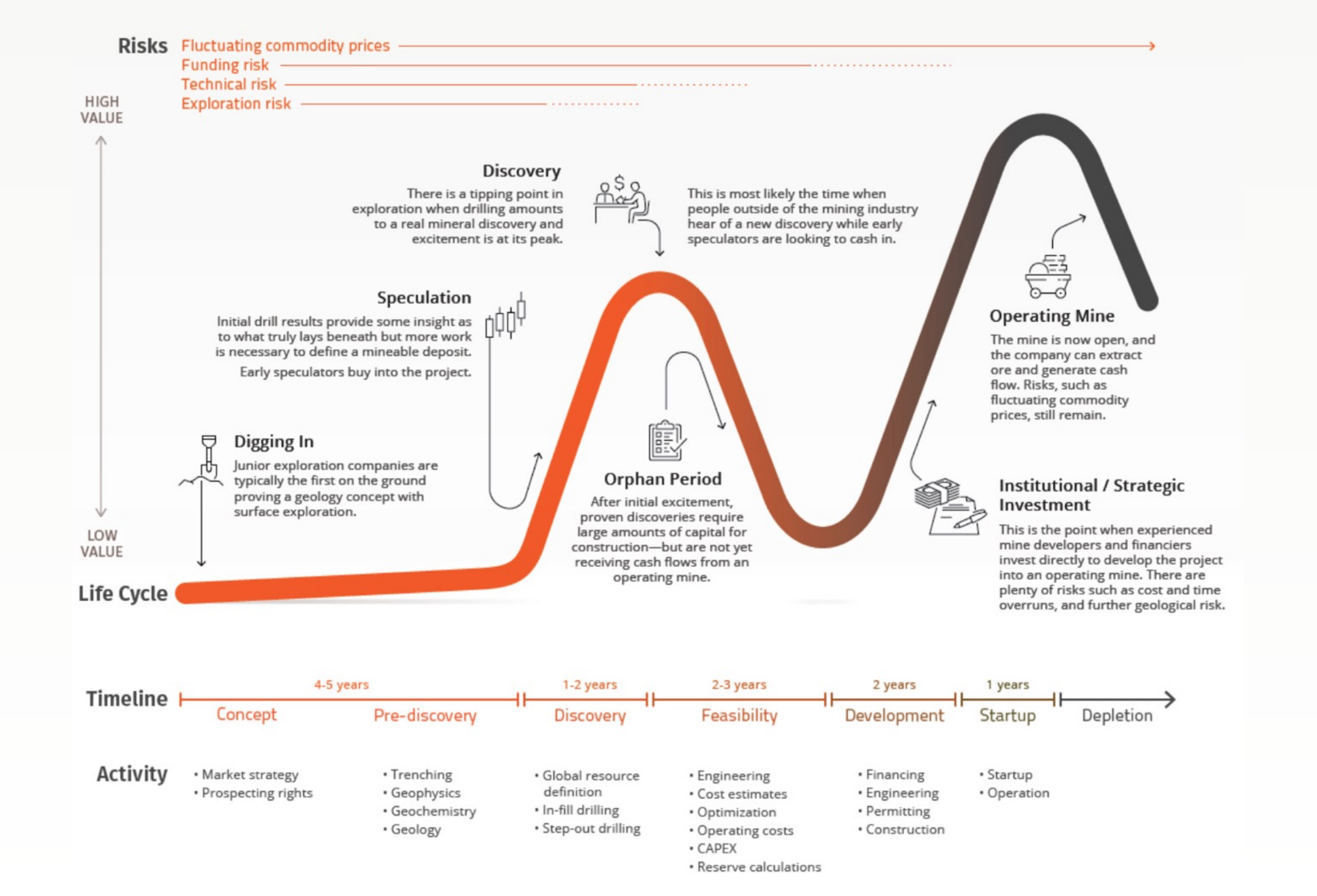

Figure 3. The Lassonde Curve - the lifecycle of a mineral discovery. Exploration companies scope the likelihood of an economically viable mineral deposit using imaging, samples and geological surveys. When they announce their results, speculators buy in to the project. Extensive drilling surveys are then carried out, and if results are promising, the value of the project increases. The early speculators then sell after excitement has peaked and before the actual mine is being built, which requires significant financial outlay and risk at a time when no revenue is being generated by the mine. If the project is approved to go ahead, banks and other financiers invest in the project – but, most mineral deposits do not gain approval. However, the dip in value of the mineral reserve between feasibility and development can prove catastrophic for a single-asset mining company. This is the "valley of death" or "orphan period", which can often last 10 years. Image from ref 27.

Over 1,800 TSFs are registered in the Church of England's tailings database and portal,[35] but this is a massive underestimate, as satellite research recently showed that there are over 2,200 TSFs in the Jing Jin-Ji region of China alone.[36] The environmental risks posed by mining waste will be covered in Environmental issues, but for mining waste reprocessing, the legislation and permitting difficulties lie in who takes over liability for the mine site – an incredibly unappealing proposition given the correlation between the age of the tailings dam (a risk factor for dam failure) and the concentration of metals contained within it. The risk of reprocessing is clear; just last year a TSF in South Africa collapsed while it was being reprocessed, killing three people and wiping out many homes in the tidal wave of toxic waste.[34,37] The lack of clarity on the legal and financial aspects of TSF reprocessing affects the potential economic viability of using mining waste as a resource and therefore represents a barrier to increasing critical metal supply.

Technical bottlenecks

The mining industry (including the mining and processing value chain) faces severely declining ore grades and higher refinery and treatment charges – all of which are negatively affecting profitability. In addition, mining companies are price-takers. This means that low cost per unit volume is the main way for miners to increase profits.[38] Because green or clean technologies are typically more expensive than fossil-powered equivalents (e.g., the recent advent of electric haulage trucks relative to diesel-powered trucks) or yield less product than conventional methods (e.g., in-situ mining versus 'traditional' mining), the mining industry has not prioritised them. 'Mining innovation' is a relatively recent concept and the goal has been to generate maximum profits, and so innovation has focused on incremental drop-in process innovations, such as better blasting techniques, as opposed to more radical innovations that would require less blasting and perhaps require the mining process flowsheet to change.[39] The mining sector would rather invest in exploration and prospecting than process innovation, as the former activities (locating and testing the economic worthiness of an ore body) are supported in economically-developed resource-rich countries and, while risky, have a higher probability of financial gain for the mining company.[39]

Innovation is the only way that the mining industry can address the technical issues facing them.[40] Unfortunately, the sector poses significant challenges to innovators. Firstly, due to lack of appeal and talent loss resulting from market contractions, there are not many people who understand the issues faced by the mining industry and who possess the skillset required to think of applicable solutions.[41] Even then, efforts to innovate in the industry are fragmented and non-systematic because the industry does not frequently collaborate with external researchers.[38] Secondly, if someone did come up with an idea, there is no access to materials or equipment with which to test and refine the idea. Due to the regulatory environment and concerns about corporate espionage, the mining industry cannot or does not easily send samples to researchers. Furthermore, if you were to find a solution that worked well for a given mine site, it is unlikely to be translatable to other mine sites (i.e., not scalable).[39] Lastly, if you managed to surmount all of the above hurdles to produce an innovative, scalable technology for mining, it is very difficult to access decision-makers who would allow you to enter, or operate on, their site as a first adopter, let alone invest in a fledgling start-up.[40] It is rather telling that the most newsworthy "start-ups" in the mining sector are actually spin-outs from established research groups (e.g. Jetti, Vinca), offshoots from businesses with mining contracts (e.g. Ceibo), or other large businesses that have alignment with mining technologies (e.g. Cemvita).

Environmental issues

Mining is, by definition, destructive to the environment and, as touched upon earlier in Feasibility & permitting, the industry has a notoriously poor track record of environmental disasters. Mining waste facilities cause the most problems, usually after the active mining phase when they are called 'legacy mines', but there are also issues that occur during active mining. It makes sense to discuss these in turn, because to scale up mining responsibly for the energy transition means we need to minimise impacts on local ecosystems and communities.

After the relatively non-invasive pre-feasibility studies, the mine is planned around calculated positions of relatively high-grade ore body. The most important decision to be made is whether to make an 'open cut' mine, or an underground mine. Open pit mining (see **Figure 4A**) is cheaper, safer for workers and better for accessing shallower ores, but is worse for the environment than underground mining. This is because open cut mining requires clearing hectares of land, and results in more waste rock being exposed to the environment, releasing toxins into the air, soil, and waterways. This is a particular issue of concern for nickel mining because a lot of nickel-containing ores are found in old-growth rainforests.[26] It is also important to note that the impacts of mining extend beyond the site; for instance, acid rain and local urbanisation are impacts of mining that have a much larger radius than the mine itself.[42]

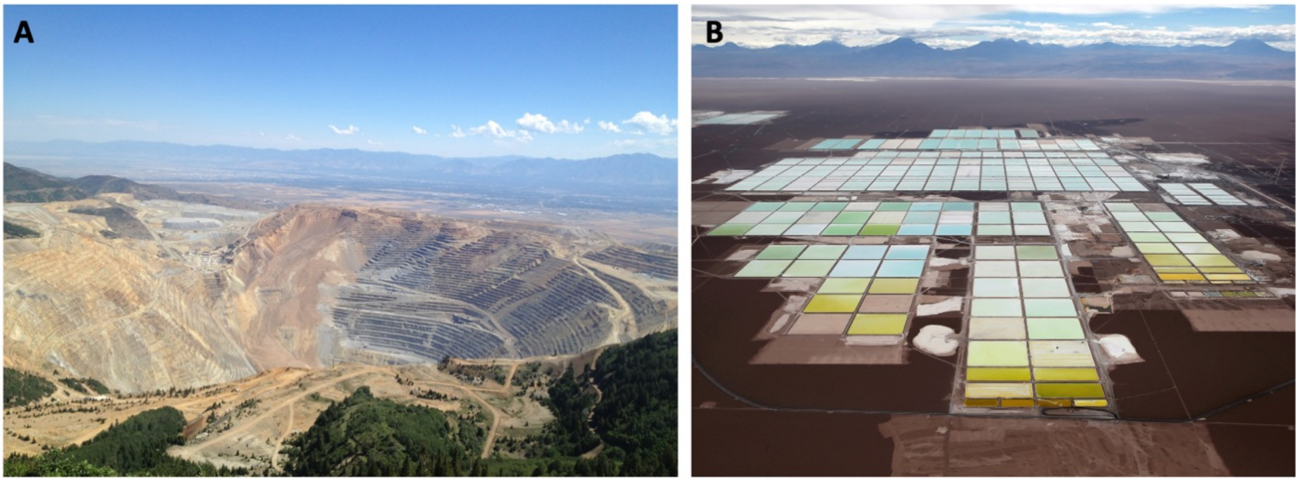

Figure 4. A: Open cut mining. This is the Bingham Canyon copper mine, which is the deepest man-made pit in the world. It is almost impossible to imagine the scale of this pit, but in the far distance, you may be able to see Salt Lake City. In the middle of the picture is a massive 70 million cubic metre landslide that occurred in May 2013.[43] Another one occurred in May 2021, but this was predicted by sensing technologies that had been put in place post-2013.[44] Image from Tours of Utah. **B:** Salar evaporation ponds used to mine lithium from subsurface brines on the Salar de Atacama, Chile. Image from Reuters/Ivan Alvarado 2021.

In addition to the complete eradication of biodiversity, due to the dust generated during mining operations, substantial amounts of water are also used to mitigate air pollution, to varying levels of success since particulate distribution is largely weather-dependent.[42] Water is also used during processing and to generate rock slurries that are more easily transported in pipes. This is cheaper than using trucks. The source of water is usually groundwater or desalinated seawater, and the huge volumes in which it is used represent a big problem in arid climates. It is worth mentioning also that, in addition to traditional hard rock mining, lithium can be extracted from groundwater brines, which are pumped to the surface and evaporated in big ponds (see **Figure 4B**).[45] This is the least carbon intensive way to produce lithium, but has very significant local water requirements; between 100-800 m^3 of water is evaporated per ton of lithium carbonate produced, which results in the lowering of the water table and subsequent desertification of surrounding communities.[46,47] A promising new technology called direct lithium extraction, which uses membrane technology to separate lithium and reinjects the rest of the brines back underground, will hopefully soon scale to alleviate this problem.[46]

After the rock blasting, crushing and grinding operations that are the most energy-demanding steps on a typical mine site (followed by haulage and transportation), crude ores are processed and refined into the metal strips or cathodes that we typically visualise when we think of metals – although lithium is purified into a whitish-green powder.*[48] In 2010, the production of copper concentrate (which is not the refined copper cathode product) was estimated to contribute 30 Mt CO_2e/y to GHG emissions – a figure that will have increased significantly since then as a consequence of lower ore grades.[48] The waste from mineral processing is watered down so that it can be moved in pipes, and then dumped into a waste storage pit, or TSF (ideally the tailings would be dewatered and the water recycled back into the process, but this does not always happen as it is expensive and time consuming). Seven billion tons of mine tailings are generated every year.[49] Crucially, tailings are particulates and are much less physically and chemically stable than the original rock.

This means that:

i. TSFs are prone to dam failures, which is a dynamic issue that disproportionately affects the Global South and that will get worse over time with climate change, and;

ii. newly exposed toxins and acidic molecules begin to react with oxygen to generate acid and free metal ions (e.g. arsenic). Some of the newly liberated molecules may contain radioactive elements. The toxic liquid that runs off legacy mining sites is called acid mine drainage (AMD). As the rain falls and the water table returns to an old mine site, AMD seeps into waterways, significantly harming environmental health.[50]

For this reason, mining companies are usually held liable for water quality monitoring and remediation in the post-mining phase for a number of years. The duration of liability varies regionally, but in Chile, for instance, it is five years. However, in China and the Philippines, mine site liability is transferred from miner to government during the decommissioning of the mine.[42] Biologically, the production of AMD generates a positive feedback loop because acidic conditions favour the growth of bacteria that generate even more acidic conditions.[51] AMD could be a solvable problem if political parties would act on this; the technology already exists but miners will not voluntarily implement it because it would increase their costs.[50]

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* Note that the mining process chain has been greatly oversimplified here and does not include electrolysis, heap leaching or solvent extraction et cetera for (i) brevity and (ii) because a discussion of these technologies would not add anything. Similarly in the discussion of TSFs, we have not included less common tailings disposal techniques such as underground backfilling or submarine tailings disposal.

Mining companies are aware of the reputational damage they could suffer upon TSF failures and are pushing for regulation themselves.[52] For example, the International Council on Mining and Metals (ICMM) is a coalition of 23 mining companies that has recently issued TSF guidance.[53] Because the ICMM is linked with well-established players who are seen as 'legitimate', other mining companies are more likely to join ICMM than alternative voluntary standards bodies, such as the Initiative for Responsible Mining Assurance (IRMA).[54] In the wake of the 2019 Brumadinho dam collapse that killed 270 people disaster, the ICMM collaborated with the UN Environment Programme and the Principles for Responsible Investing to develop the Global Industry Standard for Tailings Management. Vale recently announced that it has implemented this standard in 48 of its 50 TSFs.[55,56]

Having discussed the most pressing environmental issues caused by mining, it is important to pause, and survey suggested solutions. Given that mining companies are price-takers, the industry is not going to voluntarily become sustainable unless it senses either demand-side pressure or a requirement from investors. Demand-side pressure is steadily building following the Dodd-Frank Act in the US and the incoming EU Battery Passport regulations, which is driving the automotive sector to scrutinise their metals suppliers. The application of the Mitigation Hierarchy (avoid, minimise, restore, offset) is already required by investors, but is failing.[26] In fact, one of our workshop participants stated the need to diversify sources of capital because the leading investors in mining projects do not adequately prioritise human rights or environmental protection. With the appropriate financial instruments to make responsible mining economically viable, the industry could accelerate towards more sustainable mining practices. A few ideas include: the valuation of natural capital at pre-feasibility stage, premiums for "green metals",[57] incentives for the reopening and remediation of legacy mines, calculations of the cost of inaction (applicable to legacy sites), and so on.[58]

Social issues

Social issues and conflict around mining projects often occur because the local communities value their environment more than the mining company and often more than their own governments. Subsequently, environmental issues such as the examples above clearly cause and exacerbate tensions in mining-affected communities. In addition, the growing recognition that the benefits of mining are not adequately distributed to the affected communities or countries has diminished the reputation of the mining industry to record lows. Reputation is extremely important to mining companies because it determines their 'social license to operate'; if the relationship between the mining company and the local community breaks down, mining operations are significantly affected. To manage this, mining companies try to sweeten the deal for affected communities by building infrastructure and amenities – a tactic that also benefits the mining company as these additions assist their operations and can entice workers to the area. There is now a societal expectation that the mining sector should engage local stakeholders, invest in the community by supporting local contractors and building infrastructure, and remediate any damage caused.[59] Academics have argued that mining companies have deployed innovative business strategies to avoid having to pay for these 'corporate gifts', instead building the infrastructure and handing over the financial burden to the state.[60]

Frequently, commercial mining operations are a source of conflict because they disrupt and displace local people and artisanal small-scale miners.[61] Informal artisanal mining supports the livelihoods of almost one in 20 people worldwide (see **Figure 5** for map).[62] There have been attempts to formalise artisanal mining, but on the whole, artisanal miners cannot afford to fulfil licensing or certification requirements, so it is technically illegal. There is little interest in policing artisanal mining because restricting the opportunities of poor communities does not lead to beneficial outcomes for society; rather, it would be better for commercial miners to engage with and upskill artisanal miners.[42,63] Regulations need to be in place so that these interactions are fair. After the World Bank recommended that commercial miners engage with artisanal miners, commercial miners have moved to incorporate artisanal miners in their projects by paying them per output – without a salary or the social protection mechanisms that come with employment (i.e., corporate-sponsored wageless labour).[64] Additionally, by contracting artisanal miners, the commercial miners essentially outsource responsibility for mining on those artisanal miners.[64] This is clearly unfair. Since over 97% of the Republic of Congo's energy supply is renewable, collaborating with artisanal miners and upskilling them in the processing and refining value chain could allow more environmentally friendly mining operations alongside more sustainable development and beneficiation of local communities.[65]

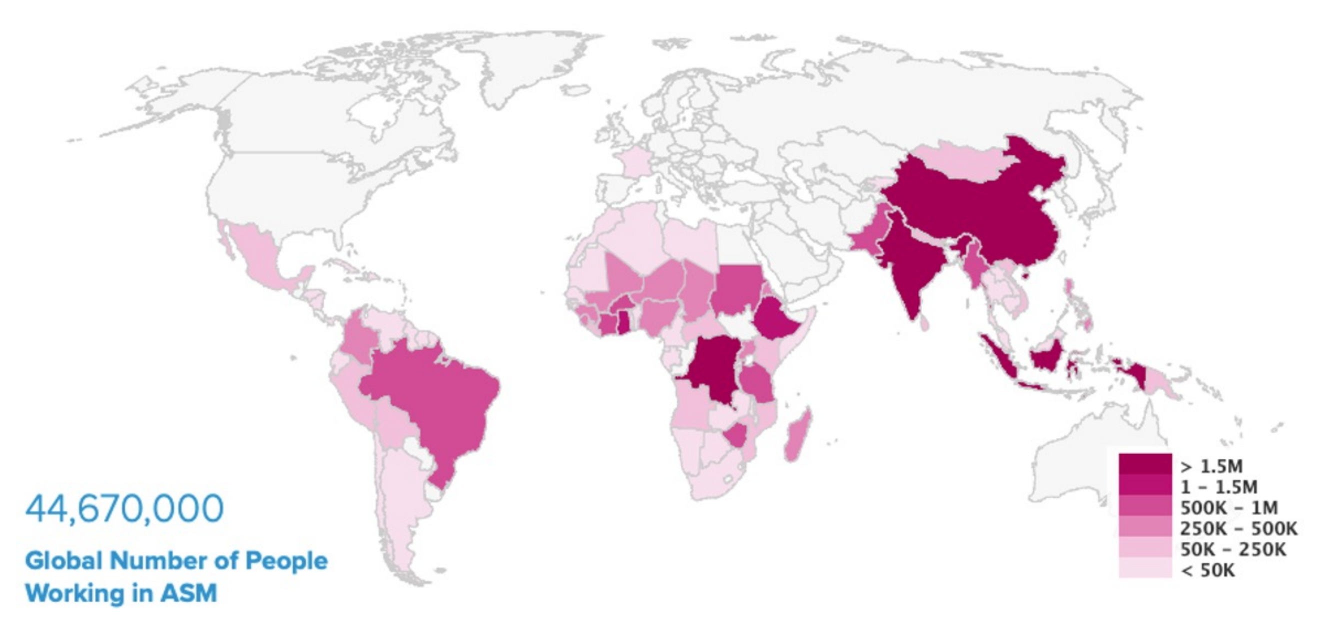

Figure 5. A map showing the number of people working in artisanal mining. The top four locations are: India (15 million people), China (9 million people), Indonesia (3.6 million people) – which produces 50% of the world's nickel, and the Republic of Congo (2 million people) – which produces ~70% of the world's cobalt. Image from ref 66. CC BY-NC.

Artisanal miners are often Indigenous people, who have a deep understanding of the landscape and a spiritual connection to certain locations. Indigenous people are experts in which areas are prone to flooding, landslides, avalanches and so on. It therefore makes sense to upskill Indigenous talent and collaborate with them to not only preserve areas of special significance (thereby reducing conflict), but also to design better infrastructure that is less at risk of interruption caused by bad weather or natural disaster. Unfortunately, due to lack of opportunity and poor sentiment towards mining companies in Indigenous communities, barely any Indigenous people work in the mining industry. We interviewed an individual who spoke of being shunned by their First Nations community after becoming involved in the industry. Now, that person has risen to senior management in a mining company and fights for Indigenous nation involvement in decision making on Indigenous lands. Their actions have resulted in the very first consent-based agreement for a mine site on Indigenous territory by the First Nations Tahltan Central Government.[67,68] This is an exception, not the norm; in Western Australia between 2010 and 2020, 460 applications were submitted by mining companies to disturb or destroy sites of potential cultural significance.[69] All but one – 459 – were approved, including Rio Tinto's annihilation of a heritage site that had been occupied by humans for 46,000 years. The destruction occurred after artefacts had been found near the site (such as a plaited belt made of human hair with direct ancestral links to the Puutu Kunti Kurrama and Pinikura people) but before more extensive archaeological studies could be carried out.[69]

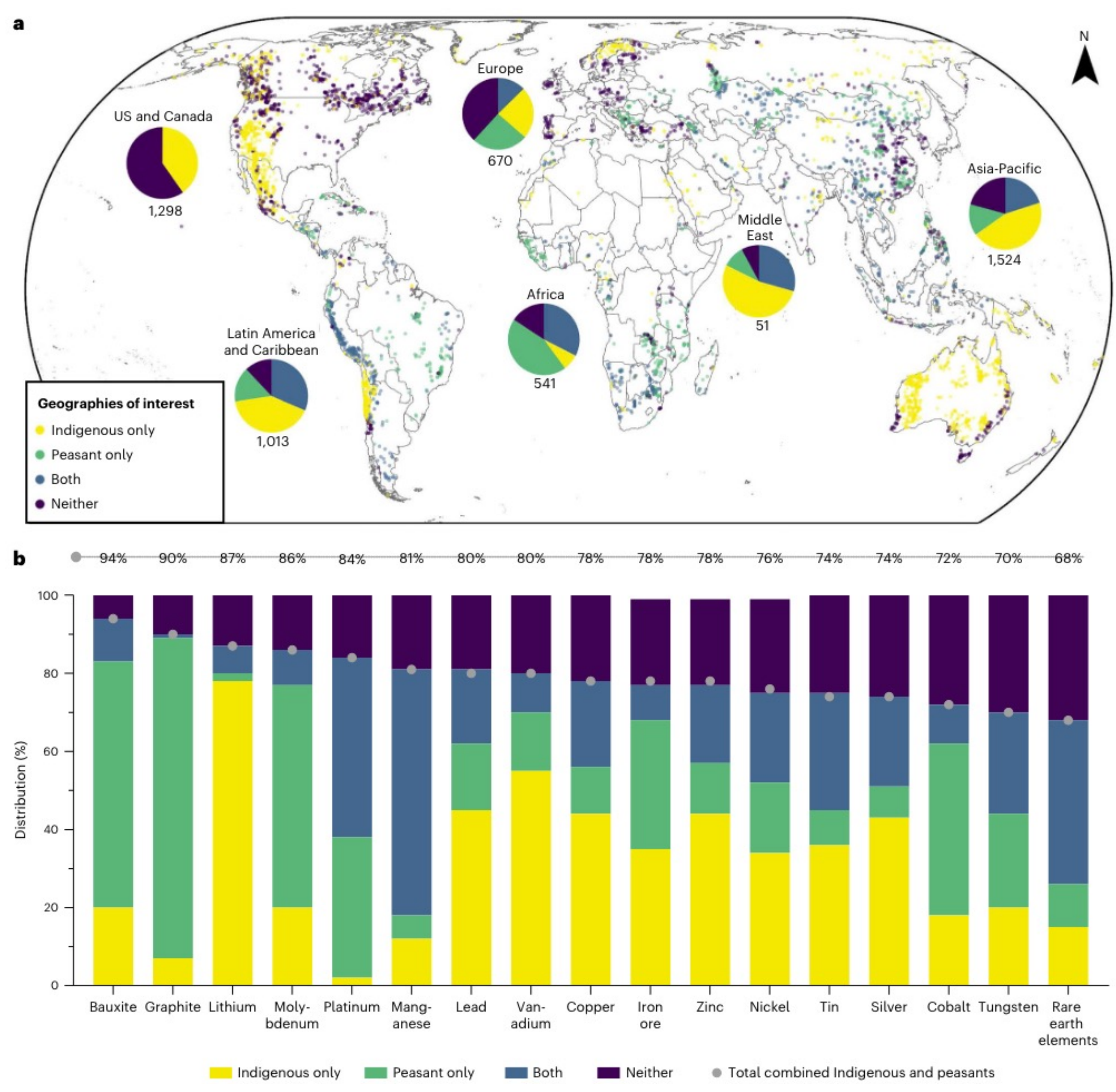

Figure 6. Map showing the locations of energy transition mineral mining projects, colour coded based on land rights. This map shows that copper, nickel, and cobalt mining operations are largely (>75%) built on land occupied by Indigenous or 'peasant' people. The 'peasant' classification is used in this publication to refer to people with rights under the UN's Declaration on the Rights of Peasants and Other People working in Rural Areas (UNDROP). Image from ref 70. CC BY.

Where recognised, Indigenous people do not have veto rights on their own land, placing them at odds with governments, and meaning that they feel they have to take their rights into their own hands to defend their land. Sadly, hundreds of 'land defenders' are killed every year (likely an underestimate, as the issue transcends energy transition minerals, and indeed the mining sector).[71] Unfortunately, a lot of Indigenous communities are not formally recognised as nations and therefore do not have the power to be involved in decision making or consenting. Even the Indigenous nations that are recognised under the United Nations Declaration on the Rights of Indigenous People (UNDRIP) struggle with the governance and administrative capacity to negotiate mine site plans.

There are three potential solutions to the lack of involvement and benefit redistribution to mining-affected communities. Firstly, vulnerable communities (not only those recognised under UNDRIP/UNDROP) require financial and hands-on assistance to increase their access to decision-making tools, capacity for free, prior and informed consent (FPIC) and to design co-ownership and other financial arrangements for their territories. Secondly, if this could be followed with an onshoring of processing and refining capabilities, local communities would benefit more from the value added in the battery manufacturing chain. Instead, we are currently in a colonial-esque situation where metals are mined in vulnerable communities, processed in China, and then shipped again to consumers in economically developed countries who do not want to think too hard about the provenance of the battery in their electric vehicle (although in the EU they will soon be forced to do so following the implementation of the battery directive). On a related note, the last solution is to increase supply by encouraging mining projects in more economically developed countries, thereby reducing the burden of mining on the Global South.

Conclusions

To most people, it would seem counterintuitive to combat climate change by scaling up mining activities. As such, there are many NGOs and philanthropists who would not invest in measures such as mining innovation. However, adequate metal supply is a requirement to achieve net zero and therefore, it is necessary to engage with the mining industry to achieve the best societal outcome: the energy transition.

There are a range of philanthropic tools that can accelerate the transition away from the mining of the past and into the mining of the future. In particular, investing in mining-related research and development could be very impactful and globally relevant, especially if new, interorganisational collaborations or innovation ecosystems can be formed. Finding ways to encourage governments to invest in mining research and development would also be effective, and would also boost mining-related skills. Supporting initiatives that encourage the growth of mining-related skills, such as geology and metallurgy, is likely to be very additional, especially if used as a multifunctional tool to increase opportunities for people whose lives and livelihoods may be particularly affected by the energy transition – for example, Indigenous people and artisanal miners. Helping to facilitate conversations between mining-affected communities and mining companies could increase the fairness of mining operations and the speed at which they are carried out.

Until new, precision mining techniques that are less environmentally detrimental have been commercialised, a high-leverage way to reduce the impacts of mining would be to work with one of the voluntary initiatives attempting to do so. There may have to be a trade-off between choosing a highly relevant partner organisation with broader reach but less stringent environmental policies versus a less impactful organisation with higher environmental standards. Nonetheless, there is also a role for stronger governance, particularly given the renewed attention to mining wastes and secondary supply of metals (e.g., urban mining). However, it is important to note that before urban mining is considered as a route to increase critical metal supply, we first need to have enough material stocks. The International Energy Agency estimates that we could reach this point by 2030. Therefore, the priority for now must be increasing primary supply to stay on track for a net zero economy in 2050.

The objective of scaling up metal supply to unblock the energy transition is one that requires a package of measures working in tandem to ensure that it is done fairly. The issues facing the mining industry are wide-ranging, and so too are the potential solutions, which will be explored further in the strategy memo. There will be a mix of interventions that can work on a global scale (such as upskilling opportunities in the mining sector), as well as local interventions to support mining-affected communities, who are disproportionately based in climate-vulnerable communities. This aligns strongly with QCF’s focus on the synergy between climate change and global development.

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