

**ALFREDO JAAR  
THE END OF THE WORLD  
2023**

**COBALT  
RARE EARTHS  
COPPER  
TIN  
NIKKEL  
LITHIUM  
MANGANESE  
COLTAN  
GERMANIUM  
PLATINUM**

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### INTRODUCTION

The metals selected for this project are “critical raw materials,” a recent European Commission defined list of resources required for the energy transition. They are defined, principally, by a lack of “security.” The definition is political, it means a high risk of supply shortages to the west.

Most of these metals are related to electricity generation, storage, and transmission, as well as data transmission and storage (data is, for the most part, electricity). They are also ubiquitous materials, used in our bodies (such as pacemakers and hearing aids) to cables that cross entire continents to convey electricity.

These materials come from a range of geological environments. Many are from ancient continental crusts called layered mafic intrusions & cratons (or simply “old and cold” as some geologists say—ancient bits of earth’s continents). Many sites are in central China and Mongolian steppes, the Andes, central and the southern African continent. Some contexts are much newer, such as the ocean floor, where manganese and rare earths are mined, and their genesis is associated with the formation of the earth’s crust in oceanic volcanoes. Some are from space: a large nickel deposit in Canada was created by an asteroid impact. The range of environments requires nearly the entire gamut of contemporary mining techniques, from the rush for deep ocean mining (so far unsuccessful) to the sublime pits that are dug for copper. Rare earths are scattered in low concentrations, so that enormous volumes of ground need to be torn up to produce a very small amount of metal.

Many critical materials are widespread but mined only in a few places. For instance, Canada has lots of rare earths but they are too dispersed, in low concentrations, and in difficult to prospect areas (i.e. forests) making it too costly to mine. China is the site for most rare earths mining, it is likely because prospecting is easier in central China and on the Mongolian steppe.

There is currently a rush for these critical materials. Solar and electric power is impossible without them. Electronics rely on them. They make communication possible. The list of this project’s selected minerals is not exhaustive, being exhaustive would be unfeasible. Instead, the list is a portrait of key metals from a range of geological environments, histories, and geopolitical contexts that are and will be responsible for the actual and future violence at the heart of renewable energies.

# Cobalt

Democratic Republic of the Congo, Zambia, Central African Republic, Norway, Greenland, Indonesia, Philippines, United States, China, Zimbabwe, Siberia, Ukraine

Cobalt is poisonous, it kills miners. Sixteenth century German miners called it the Black Devil. Twenty-first century geopolitical tensions between China and the United States are emerging around it. In 2020, sixty percent of the world's cobalt went into rechargeable batteries. A standard electric vehicle uses about ten kilograms. Phones and laptops also contain cobalt. China controls half of the world's supply for their rechargeable battery industry. Chinese state backed companies poured huge resources into opening new cobalt mines in Zambia and Congo as part of the Belt and Road Initiative. Those states are now aligned with Chinese interests in an arms race to dominate the energy transition, driving other states to locate new sites of extraction. There is currently no mineral alternative to cobalt, which means that the Central African Copper belt, nearly four hundred and fifty kilometres long, will be exhausted, destroyed, and turned to waste by the energy transition, while funding conflict and corruption.

Many cobalt mines in Congo and Zambia are artisanal, operated by freelance miners, guarded by militias, and used to finance civil wars. Miners handle cobalt with their hands, many are children. Russian mercenaries, the Wagner Group, have been protecting gold mines in the Central African Republic in return for mining rights, the profits are used to buy weapons for their occupation of Ukraine. There are concerns that this strategy will spill over to cobalt mines. It is known for certain that funds from cobalt mines have been used to buy weapons and ammunition for Congolese militias since the early 2000s. Benedikt Sobotka, co-chair of

the Global Battery Alliance, wrote that “Unfortunately, there is almost a 100% chance that your smartphone or electric vehicle contains cobalt that comes from child labourers in artisanal mines.”

The race to find new deposits of cobalt is rife with tension, too. Competition is emerging between tech billionaires and Norwegian companies to prospect Greenland as climate change melts the ice sheet there and cobalt reserves emerge. Indonesia became the second largest producer of cobalt in 2022 but its mining sector relies on systematic forced migration, vast environmental destruction, and violence. Investment from Chinese firms into the Morowali industrial estate in Indonesia for electric vehicle manufacturing has resulted in workers deaths, mining waste dumped in the ocean, and outbreaks of respiratory illnesses.

The recent election of Ferdinand Marcos Jr., in the Philippines—son of the dictator who plundered the country for two decades—lifted cobalt mining moratoriums and will likely use concession sales to intensify competition between the United States and China over access to mineral wealth in Southeast Asia. In 2023, Huayou Cobalt took over operations of the Arcadia cobalt mine in Zimbabwe on the southern edge of the Copper Belt, which looks like an attempt to diversify cobalt sources away from the DRC and expand the reach of the Belt and Road Initiative to more African states. Reports have emerged that Nornickel, which is owned in part by Vladimir Potanin, a Russian oligarch close to Vladimir Putin, is seeking to expand its cobalt mining into the southern provinces of Siberia, increasing its influence on the global green energy market in competition with China and the United States. The renewable energy revolution is creating new opportunities for resource nationalism and inevitable tensions on a global scale. States will use aggression to secure their supply chains, engage the services of weak states, or turn to the black-market minerals trade.

# Rare Earths

The moon, China, Inner Mongolia, Afghanistan, United States, Myanmar

Rare earths are not rare, some are more abundant than copper or lead. But they are not often in concentrated deposits. The total volume of ores required to produce all the world's rare earth metals in 2018 was equivalent to nearly twenty-three Great Pyramids at Giza. They matter because they are difficult to get and are central to nearly all digital technologies in a post-carbon world. Rare earths make magic—phone and television screens are luminous and swipe and zoom and create the illusion of reality because of them. Semiconductors, capacitors, sensors, are all embossed, mixed, or lined with rare earths. Wind turbines turn, electric vehicles move, because of them. Rare earths make us think that machines are animate. Corporations and states are viciously competing to find more of them, creating zones where people and places are sacrificed to toxicity, and militias are funded. There are even plans to mine the moon for rare earths.

In 1992, Deng Xiaoping said, “The Middle East has oil; China has rare earths.” The centre for China's production of rare earths became Bayan Obo, in Inner Mongolia. Soon after, Chinese mining companies produced over sixty percent of the world's rare earth minerals. The results were devastating. Tailings ponds caused cancers, chronic arsenic poisoning, skeletal fluorosis, and long tooth disease. The pond became the “world's largest, rare earth lake,” and a dam burst could devastate the region.

Claims have been made that Afghanistan may contain as much as half of the world's supply of rare earths. This optimistic vision was offered by a mining director and linked to

geopolitical manoeuvring. One member of the conservative Fraser Institute used Afghanistan's rare earth mineral abundance as a reason for continuing the United States occupation of the region. In 2021, CNBC and CNN ran reports suggesting that Chinese authorities were colluding with the Taliban to access the minerals and further cement their dominance of the global trade. More concerning is how in the Northern Myanmar state of Kachin, local militias are colluding with Chinese traders to open the region to rare earth mining. Over two thousand tailing ponds and collection pools have been recorded there with satellite photography. Concerns are that the profits from the mining are moving through the militias and into the pockets of military leaders linked with the state and military dictatorship. There are currently no remediation measures for low-tech mining techniques and the risk is that pollution could begin to infiltrate the Irrawaddy River system that connects the entire state to the Indian Ocean.

Even the moon has become a new frontier. Six national space programs, fifty private companies, and one university engineering program are currently developing strategies to mine the moon. No one owns the moon, yet, but it has been prospected. The Western Lunar Highlands is projected to contain massive reserves of rare earths, some have called it a "lunar treasure chest." Silicon Valley engineering companies and financiers are looking eagerly at outer space mining. AI technologies are likewise being used to prospect Greenland for rare earths as the glaciers retreat. Frontiers are not found, they are created; they are the products of technological, geopolitical, and capitalist forces.

# Copper

Indonesia, New Guinea, Bougainville, Peru, Chile, Brazil, China

Refined copper is one of the most ubiquitous materials in the world. Every computer command, every transaction of every bank, all crypto currencies, exist, at least for a time, as movements in copper. The world's copper cables are a planetary scaled scaffolding for electrical flows. Sourcing more copper for the energy transition is threatening to create new civil wars, ecological dead zones, accelerate climate breakdown, and economic inequality. In 2022, nearly one billion pounds of copper was laced through cars. The known reserves of copper may be exhausted within a century and the hunt is on to find more. Today, the largest copper mines in the world are in South America and Indonesia.

In 1981, one of the world's largest mining companies, Freeport Mineral Company, opened a copper mine in New Guinea which extracted thirty-two million tons of copper, gold, silver, and had an annual income of three hundred million dollars, almost none of which went to local Papuans, whose society the mining destroyed. The mine at Grasberg mountain made wetlands, according to a company funded study, "unsuitable for aquatic life." Twenty-seven billion pounds of copper has been removed from the site since 1990, which is the equivalent weight of nearly thirty-five empire state buildings. The mine created an armed West Papuan independence movement, resulted in death and imprisonment of activists, enriched the Indonesian oligarchy which continues to enable the mining, and subject Papuans to poverty and exclusion from Indonesian society.

Mining giant Rio Tinto worked on the island of Bougainville, east of New Guinea, at the Panguna copper mine. The company built a segregated town that separated white mine managers from local Buka people. The disposal of more than one billion tons of mining waste into the Kawerong-Jaba River delta caused birth defects, species extinction, and the destruction of livelihoods. The situation created a civil war that killed more than twenty thousand people. Only one percent of the profits from the copper was estimated to have been shared with the people of Bougainville. The mine was shut down in 1989 but Rio Tinto is currently exploring the possibility of re-opening it to meet rising global demand for copper for the energy transition, raising the prospect of a new civil war.

Chinese state-owned mining companies and South American governments are forming new geopolitical alliances to resist western hegemony. Most of the copper produced in Chile and Peru is sold to China, much of it used in green technologies. A town of twenty-five thousand people beside Chile's largest copper mine was relocated in 2014 because pollution made the place uninhabitable. Chinese company Shougang, who also owns Peru's largest copper mine, was sanctioned by the Peruvian government for dumping chemical waste into the ocean. Chile accounts for nearly one third of global copper supply but environmental devastation caused by mining and climate change, and disputes with communities, create price surges, which leads to the expansion of illegal copper mining in the Brazilian Amazon, deforestation, displacement of indigenous communities, and the escalation of climate breakdown.



# Tin

China, United Kingdom, Malaysia, Indonesia, Myanmar, Bolivia, Peru, Kazakhstan, Russia,  
Democratic Republic of the Congo, United States

Most tin is in huge provinces in Southeast Asia, south China, the Andes, and Cornwall. Much of the tin mined in the last four thousand years has been removed from these places. Tin made the modern world, tin cans enabled preservation and shaped globalisation. Tin makes solder, and solder makes electricity flow, without it there will be no renewable energy grid; tin is the great connector. The surface extraction of tin for the energy transition is chewing up landscapes and river systems with multi-generational consequences on livelihoods. Coral reefs are being destroyed causing conflict between miners and fisher people. Populations are being displaced from mining areas, leading to migration related community stresses. Illegally traded tin ores in the global supply chain are shoring up tin mafias and armed conflict.

The industrialisation of tin mining in Malaysia resulted in huge environmental costs. Rivers were turned to sludge, which one writer described as “the colour and consistency of tomato soup.” Riverbeds were raised by nearly a meter, exacerbating flooding and the inundation of agriculture with tailings. Canals and flood retention works were built in Kuala Lumpur and Ipoh to combat the possibility of new flooding. A village of two thousand people, Balun Badai, was transformed into a swamp. Kualu Kabu, a small market town, was buried under five meters of mine tailings. An estimate in 1939 put the production of silt from mining in Malaya at sixteen million tonnes annually, nearly twice as much as the amount removed for the three tunnels built to connect France with Britain. The results continue to haunt Malaysia.

Vast denuded dead zones in former tin mines lose huge volumes of sediment and make river systems, and thus agriculture, unpredictable.

Tin mining continues, however, in Sumatra, Myanmar, and other areas in Southeast Asia. The Southeast Asian tin belt produces nearly forty percent of the world's tin, followed by south China, the central Andean tin belt (which crosses Bolivia and Peru). New reserves have been located in Kazakhstan, Yakutia Russia, and the eastern Democratic Republic of the Congo. Nearly forty percent of the world's tin is produced by artisanal miners, which often means they are loosely regulated, if at all. On the Indonesian island of Bangka, which has been intensively mined since the Dutch colonial period, one observer wrote that "one can foresee a time when there is nothing left but a dead skeleton." Much of the mining on Bangka is managed through shady cartels with links to the country's oligarchs and military.

Tin is so valuable because the world's major reserves are in only four places. The United States and the European Union have included tin on their so-called critical minerals lists which western states have been compiling since the second world war. The purpose is to identify materials with risky supply chains. Most of those materials were crucial to war efforts and industrial development in the twentieth century, now the materials are overwhelmingly related to the energy transition. Western states cannot transition to net zero energy without engaging with governments that are antagonistic to western hegemony, embroiled in armed civil unrest, or on a development path that disregards environmental protection. The irony is that many of these places, such as central Africa, South America, and Southeast Asia continue to be affected by histories of European and American imperialism. In many cases, it was the mineral wealth of these places that was so voraciously exploited by colonial powers in the first place. Some of the world's largest mining companies emerged

from that period. Critical materials lists represent both the history of western conquest *and* contemporary anxieties about the effects of that conquest.

# Nickel

Indonesia, Philippines, Russia, New Caledonia, Ukraine, United States, China, Japan, Brazil,  
Canada

The unprecedented demand for nickel for the energy transition is creating shortages in the supply chain. Illegal mining, offshoring, deforestation, death, and a new race to the bottom are the result. Nickel is essential for energy storage, it helps keep the charge of an electric car, a single battery contains about forty kilograms of it. It is also crucial for steel, and any future renewable energy infrastructure will require more nickel and, therefore, more mining. Most nickel comes from Indonesia, the Philippines, Russia, and New Caledonia primarily through strip mining, which destroys forests and turns mountains to rubble. In 2022, the war in Ukraine and the global rush to produce electric vehicles increased the price of nickel by nearly thirty-five percent. Mined production rose by nearly twenty percent, nearly all of it from Indonesia, exacerbating inequality, environmental destruction, and conflict between China, the United States, and Southeast Asia.

One of the world's largest nickel mines is in Sorowako, Indonesia, and is managed by PT Vale, which is partly owned by the Indonesian and Brazilian governments, with Canadian, Japanese, and other multinationals holding stakes. The concession at Sorowako is nearly the size of greater London. The actively mined area is fenced and policed and the profits from the mine are almost entirely exported elsewhere. The town of Sorowako is in disrepair, migrant labourers live in shacks on the nearby lake or in hastily built dormitories that don't have refuse collection; instead, garbage is burned in the playground.

Demand for nickel drives illegal mining. At one site in Sulawesi, Indonesia, nearly fifty million tons of nickel has been mined unlawfully since 2019. Local police were paid off, documents forged, forests cleared, and waste dumped. The nickel was then sold to Chinese companies to be used in batteries. Since 2019, at least ten workers at Gunbuster Nickel Industry, also in Sulawesi, have died in fires or landslides. One miner drowned in his front-end loader when a landslide pushed it into the ocean. In 2023, trade unionists protested the company, demanding safety. The result was a riot that led to a worker's dormitory being set on fire. Two workers died. Gunbuster Nickel Industry is a Chinese owned company with financial links to the President of Indonesia and the Indonesian military.

Primary forests are due to be destroyed in the Philippines to expand nickel mines. More than two-thousand hectares of rainforest will be razed on Mount Bulanjao, destroying the livelihoods of Indigenous Palawan people. Deforestation sends wildlife into increasingly urbanised spaces, exacerbating tensions with humans, the transmission of infectious diseases, and the illegal wildlife trade. Much of the nickel will pass through refining stages in Japan and end up in Tesla cars in American show rooms. The Japanese mining giant, Sumimoto Metal Mining Co Ltd owns a twenty five percent stake in the Rio Tuba mine in the Philippines. Between 2016 and 2020, seventy-three environmental activists and indigenous people were killed there in extra-judicial executions for opposing the mines and related environmental destruction.

Chinese renewable energy companies are offshoring cheap labour and turning Southeast Asian into a new colonial periphery. Labour regulations are lax there, environmental oversight barely exists, illegal logging and mining is rife. The oligarchies that control Indonesia and the Philippines have accepted the narrative that the energy transition is their

chance for economic growth, that development requires destruction, and that some people and places will be sacrificed.

# Lithium

China, United States, Chile, Mexico, Argentina, Australia, Tibet, India, Pakistan, United Kingdom, Portugal

The atomic bombs dropped on Hiroshima and Nagasaki were made with lithium. More recently, lithium is driving the energy transition, mainly in rechargeable batteries for electric vehicles and communications technologies. The search for more lithium is leading to new colonial occupations, agricultural land degradation, violent protest, and the prospect of funding drug cartels. Some have called lithium the gold of the twenty-first century, or white oil. The largest Chinese electric vehicle companies control nearly eighty percent of global raw material refining capacity for lithium-ion batteries, giving the state a near monopoly on the development of renewable technologies. Recent tensions between the United States and Chinese governments is driven, in large measure, by China's global domination of renewable energy technologies.

In 2018, Tianqi Lithium became the second largest shareholder in Sociedad Quimica y Minera, a Chilean company and one the world's largest lithium producers which is extracting ground water at unsustainable rates in an arid region. Lithium extraction in the Atacama Desert, Chile, is pushing indigenous Kolla people away from their land. Mines have been blocked and violence has flared. Lithium deposits discovered in Mexico occur in regions controlled by drug cartels and risk being used to fund the global trade in narcotics and weapons.

Gangfeng, a majority shareholder in Lithium Americas', is developing mines in Argentina and the United States. The company proposed to open a one-hundred and eighty square kilometre open pit mine in Nevada at Thacker Pass, an ancestral site for Indigenous people. A tent city was built to block the mine, but a court injunction allowed the mine to go ahead. Tianqi Lithium holds fifty one percent stakes in Australia's Greenbushes mine in Western Australia. The friction for Australia is that China is its largest trading partner and importer of raw materials. In return, the Chinese government makes massive investments in Australia's mining sector and real estate. Australia depends on Chinese capital while having to maintain trade and diplomatic ties with the United States and Europe.

In the Tibetan plateau at the Ganzizhou Rongda Lithium mine in 2016, protesters threw dead fish on the street of a local town in anger at the poisoning of their rivers. Lithium mining on the Tibetan plateau has been a way for the Chinese state to colonise the contested area. In 2022, a study found that climate change was benefitting the production of lithium in Zabuye Salt Lake in the Tibetan Plateau because of the rise in lake temperature, raising the prospect that warming will enable new green energy mining in disputed territories, extending the reach of extractive capitalism to earth's highest mountains and most remote places.

In early 2023, the Geological Survey of India announced that it found a lithium deposit of nearly six million tonnes. The deposit happens to be in Kashmir, only thirty miles from the Line of Control that separates India from Pakistan, a geography rife with tension since the partition of India in 1947. More recently, the Indian government revoked Kashmir of its constitutionally protected autonomy and put the region in an indefinite militarised lockdown and blacked out all communications. The Jammu and Kashmir region is a mixture of Hindu



and Muslim communities where tensions can be easily enflamed. Mining will exacerbate these conflicts and inequalities as people are displaced to make new mines.

New lithium mines in Cornwall and Portugal have led to protests in cities. Rural Portuguese are concerned about the volume of water that will be drawn away in an arid region. The World Bank projected in 2020 that the production of lithium may increase by five hundred percent by 2050 to meet green energy demands alone. It is not a question of *if* there will be conflicts around the lithium trade but at what scale.

# Manganese

Ukraine, Russia, Pacific Ocean, Canada, Belgium, China

Manganese is in us; our bones and cells need it. Manganese also made the modern world; it is irreplaceable in the production of steel. Trains, bridges, skyscrapers, ships, automobiles, are laced with manganese. In the late 1950s, manganese was added to alkaline batteries and powered the transition to consumer capitalism and its vast waste stream. Between 1992 and 1996, Duracell sold over twelve billion batteries, nearly two per person on earth at the time. Today, mining companies yearn for more manganese for rechargeable batteries and more steel for the energy transition. They are looking to mine the ocean floor for the first time ever. The danger is that we know more about the ecology of the moon than we do about the deep ocean floor. We are racing into ecological destruction with consequences we cannot even fathom. On land, manganese is causing the war in Ukraine as the Russian empire seeks to be a player in the post-carbon world economy.

The Clarion Clapperton Zone in the Pacific Ocean is an area nearly four and a half million square kilometres and with one of the highest known concentrations of manganese on earth. Estimates claim that there are nearly twenty-one billion tons of nodules containing, in addition to manganese, also cobalt, copper, and nickel. An area larger than India has been given over to exploration concessions by private companies from Canada (DeepGreen) and Belgium (Global Sea Mineral Resources) with backing from Maersk and the fossil fuel pipeline group Allseas. The companies are currently developing processes of combing the sea floor and sucking up the nodules, like large vacuum cleaners. The success has been minimal so far. One of the problems, though, is that no one knows the effects the mining will have on

the sea floor. The deep oceans are one of the least understood regions on earth. Mining companies tend to view the ocean floor as a dead space. Nodules though, it is increasingly understood, are not simply inert rock debris, they are lively habitats for organisms that are unknown to us, that live in an ecology that we have not even studied. We do not know how they relate to systems on the ocean floor or how those systems connect upwards into the water column and out into the entire ocean, nor the consequences that removing them will have on the ocean system as a whole.

The search for manganese is likely motivating Russia's aggression in Ukraine because the region contains major deposits of rare earths, nickel, graphite, lithium, and manganese. The Russian economy is heavily dependent on fossil fuel exports to the west and China, and in 2021, fuel, energy and steel made up sixty-five percent of the country's exports. As major economies shift to carbon neutrality, Russian capital is under threat and stealing Ukraine's vast mineral wealth is a possible solution. Armed conflicts have unfolded in the Donbas region of Ukraine since 2014 and today it is one of the fronts of the Russian invasion. The Nikopol Manganese Basin is in the Donbas and is a deposit that contains more than two billion tonnes of manganese. Since February 2022, forty-four people have been killed and over two hundred injured in the city of Nikopol. Nearly three thousand buildings have been destroyed. Russia wants Nikopol's manganese.

The energy transition is creating these new extractive frontiers. Humans and non-humans are being sacrificed. A single manganese nodule takes more than a million years to form, it is connected to some of the most ancient planetary processes. The Nikopol Manganese Basin in Ukraine is nearly thirty million years old. The transition to renewable energy is erasing these temporalities and creating the illusion of energy sources untethered to earth processes.

# Coltan

Democratic Republic of the Congo, Taiwan, China, United States, United Kingdom, Brazil,

Venezuela

Coltan is invincible in your life and your use of it exacerbates strife. Coltan is behind your computer and phone screens, making the flow of images flicker past, opening, and closing browser windows, vibrating phones; it makes electricity flow in wind turbines and electric vehicles. Coltan is the ore from which tantalum and niobium are derived. Tantalum is used in capacitors in semiconductors, a semi-conductor is essentially electrified silicon, and tantalum regulates the electrical charge. Coltan is now crucial for the electronics that run the energy transition. Most coltan is mined by artisanal miners, including child labour, in the Democratic Republic of the Congo. The increasing demand for coltan is also driving corporations and miners to destroy the Amazon while often hiding their supply chains. Chinese threats to invade Taiwan, and potentially cause a global war, are attempts to control Taiwan's semiconductor manufacturing, an end point in the coltan supply chain.

Congolese artisanal miners are constantly negotiating global coltan price fluctuations. They use prices to leverage any profit and create a sense of having a future. Some miners are in debt, others have been driven out of agricultural ways of life by decades of civil war. The middlemen and technologies that measure ores are all subject to manipulation. When there is a price hike at a global scale it can create chaos on the ground: money, people, tools move, new mines open-up, old ones close, porters, vendors, sex workers, tax collectors, militias all follow. In the early 2000s, the launch of PlayStation 2 at Christmas emptied the global supply of coltan and drove a price spike in the DRC and with it a barrage of new mines. When

NGOs encouraged the United States government to ban the import of conflict minerals in 2010, President Joseph Kabila shut down the artisanal mining trade for six months, driving miners to join militias as an alternative form of employment. Recent attempts to tag some minerals as conflict free are still aspirational and many miners see them as price gouging by foreign capitalists. Sourcing coltan from outside the DRC will be devastating to miners if there is not something sustainable to replace it. There is no way to ensure that the coltan in your phone is conflict free.

In 2019, the United States imposed sanctions on the export of semiconductors built in the USA to Huawei, forcing Huawei to turn to domestic sources, including the use of forced labour in Uyghur detention camps. British Telecom agreed to tear out all Huawei equipment from the 5G network by 2027 and replace it with Ericsson equipment. Ericsson has said that it has “actively chosen not to ban any minerals from the DRC or other conflict-affected regions,” because embargos can negatively affect vulnerable groups.

Chinese threats to invade Taiwan are driven in part by Taiwan’s control of manufacturing semiconductors, which the mainland wants to incorporate to make up for its semiconductor deficit. War with Taiwan could escalate into a global war. Venezuela’s mining arc, where coltan is also mined, is notoriously violent and minerals are used to fund militias. The ores are smuggled through Brazil. Minas Gerais, one of Brazil’s largest producers of niobium, has killed nearly three hundred people since 2015 in mudslides of toxic waste. The need for capacitors in the energy transition is creating more artisanal mines in the DRC, drawing children into them, financing armed groups, killing indigenous people, and destroying the Amazon. Green energy mineral commodity chains generate friction and violence all along them, from the ground to the screen.

# Germanium

Canada, China, United States, Russia, Democratic Republic of the Congo, Finland, India, Peru, Australia, Kazakhstan, Mexico

Germanium creates solar energy. Most financial transactions move through germanium laced fibre optic cables. Computers have germanium in their semi-conductors. Orbiting satellites are powered by germanium. The United States military uses germanium in night vision goggles. Mostly, germanium is produced in Canada, China, the US, Russia, the DRC, and Finland as a by-product of zinc. Germanium production involves refining imported zinc. The race for germanium is therefore a race to secure zinc and the entire supply chain that begins in the ground and ends in the refinery, often halfway across the world. States and corporations are securing their germanium supply chains by destroying Indigenous land, contaminating groundwater, sacrificing places and populations.

For the first time in history, the global production of solar energy reached above one terawatt. The world's largest solar farms are on Chinese soil at Longyangxia, Huanghe, in an area nearly seven hundred square kilometres. The Pavagada Ultra Mega Solar Park in Andhra Pradesh occupies an area the size of Manhattan. The Bhadla Solar Park in the Rajasthan desert is nearly half the size of Paris and contains over ten million solar panels. Most of these installations use germanium somewhere on the solar panels, often in semi-conductors. Solar energy fields are expanding and the conductive efficiency of germanium is making it more valuable to states and private companies.

The town of Cerro de Pasco in Peru has had its drinking water contaminated by zinc mining for germanium and at least two and a half thousand children have been chronically poisoned. In 2014, Indigenous Australians in the Northern Territory protested Glencore, one of the world's largest mining companies, at the McArthur River zinc mine because one of their waste pits spontaneously combusted and became permanently on fire. Fish died in the river and residents were scared for their safety. In 2016, Kazzinc, Kazakhstan's largest zinc refinery (owned in part by Glencore) dumped high concentrations of cyanide into the Ulba river, turning the water cement grey.

The world's largest zinc mine, Red Dog Mine, is in Alaska, and described as 'Americas most toxic site,' based on the Environmental Protection Agency studies of the toxic output for all mining activities in the United States. Plans to close the mine by 2026 were stalled because geologists found new deposits of zinc laden with germanium. The Canadian mining company Goldcorp was found to have destabilized local resident's homes with the explosions used to expand their mine at Peñasquito, Mexico. Residents established blockades to the mines. Their groundwater was contaminated with cyanide and mercury.

All renewable energy technologies that use germanium are haunted by the violence of mining, by its dust and pollution and destruction. Every solar panel connects to the dead zones created by zinc refining; virtual reality headsets are rooted in the actual hellish innards of Red Dog Mine. It is not a question of whether or not to transition away from fossil fuels but *how* that transition relates to mining, all mining, and its violence.

# Platinum

China, Russia, Canada, Zimbabwe, South Africa

The green energy transition is a twenty-first century resource war. Casualties are mounting. As China gains global energy dominance it is drawing South America, Central Asia, Southeast Asia, and Africa into its sphere of influence. With Russian collaboration, China is also looking to dominate the Arctic, forcing out European and Canadian power. Platinum is at the vanguard of these realignments because it is essential for green hydrogen, electronics, and semiconductors. It is also one of the rarest metals on earth and almost all of it is currently found in three places: Zimbabwe, Norilsk, and South Africa. South Africa alone accounts for seventy five percent of global production. Mining there is rife with social violence. An MIT bulletin claimed in 2014 that “the Earth simply does not contain enough [Platinum Group Metals] to support a global renewable-energy economy.” Scarcity stokes capitalist geopolitical competition.

In 2012, miners at the Marikana platinum mine in South Africa went on strike against low pay and deadly working conditions. Fearing an outbreak of strikes across the platinum belt, President Jacob Zuma ordered the military to attack the workers. Forty miners were killed and seventy-eight injured, many were shot in the back of the head as they ran from soldiers. Shortly after, the BBC reported that “the price of platinum reached its highest level in six weeks due to the killings,” raising the profits of the mining company and compelling more workers into the mines.



Today, the Bushveld platinum complex is dotted with informal mining camps where violence and insecurity proliferate. A 2019 study in Rustenburg, a settler town at the base of the Magaliesberg platinum mines, found that one in four women were victims of sexual violence, nearly double the average for South Africa. The study attributed the drivers of the violence to the platinum mines, economic insecurity, and wealth disparities. The consequences for victims include post-traumatic stress disorder, depression, substance use disorders, HIV acquisition, and cycles of intergenerational risk. As the South African economy crumbles and platinum prices soar due to the Russian invasion of Ukraine, people are surging into the mines, riling tensions and poverty while mineral wealth is exported to company coffers out of the country.

In Xinjiang, where Sinopec is installing one of the world's largest green hydrogen projects at Kuqa, the plant is being used for Han Chinese colonialism in a Uyghur region. Uyghurs are excluded from high level positions at Sinopec and reports have emerged of Uyghur forced labour internment camps contributing to the electronics supply chain.

As climate change melts the Arctic, Russia is looking to mine it, stoking geopolitical struggles over the region. Nornickle is opening one of the largest platinum mines in the world near Taymyr and will ship the ores through the Northern Sea Route which China and Russia are collaborating to control. Russia has reopened more than fifty Soviet military bases in the Arctic in part to secure the flow of green energy minerals from the region.