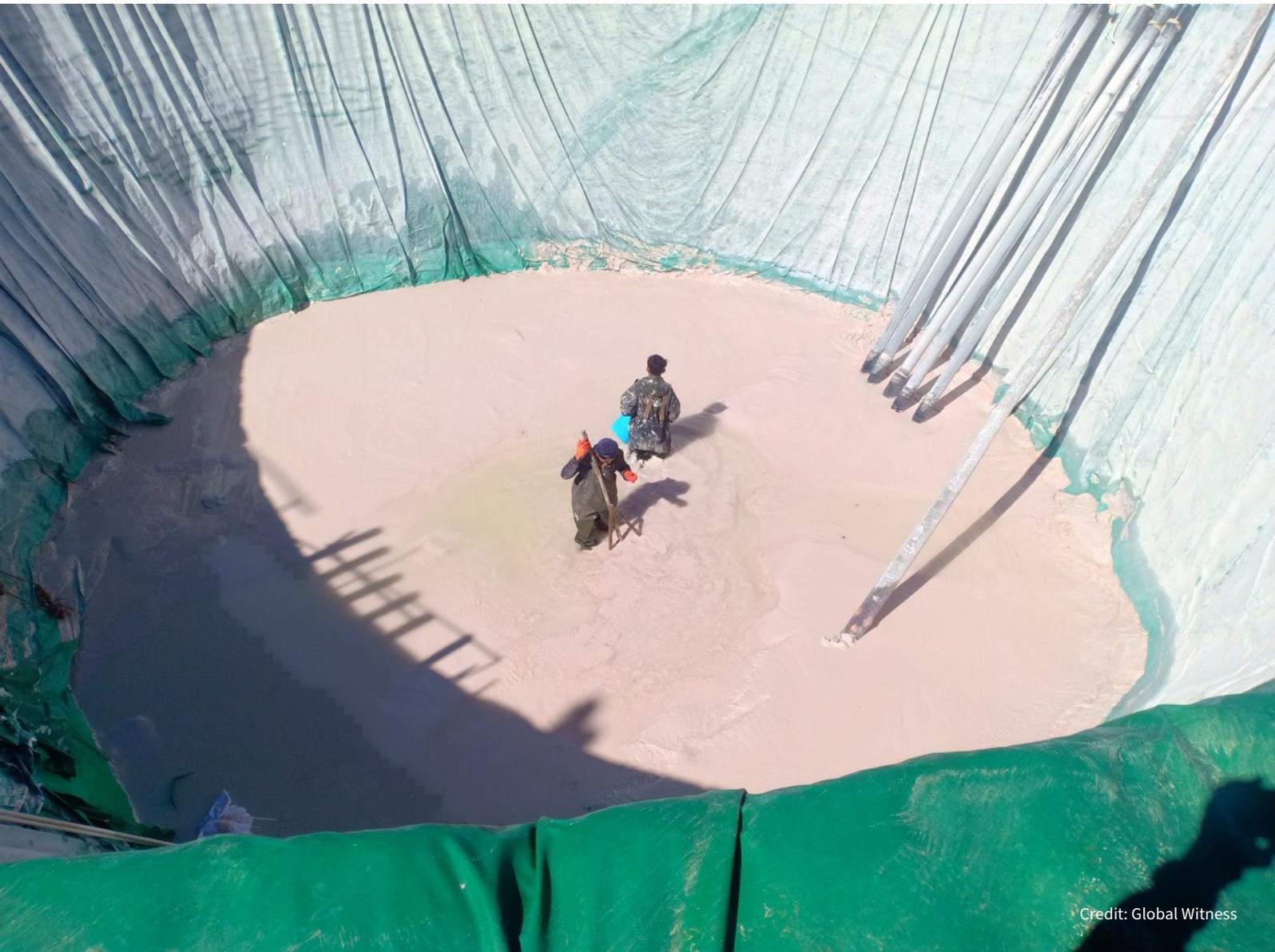


# HEAVY RARE EARTHS SUPPLY CHAIN RISKS

Illicit minerals from Myanmar are the world's largest source of supply

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**August 2022**



## INTRODUCTION

The global economy is becoming increasingly reliant upon rare earth minerals, the ores of 17 metallic elements that are a key part of renewable energy solutions to climate change, enabling us to reduce our reliance on fossil fuels.

Two of these elements, dysprosium and terbium – classified among the so-called heavy rare earth elements – are particularly valuable. Among other applications, these metals are used to make high-strength permanent magnets used in electric vehicle motors and wind turbines. Dysprosium and terbium are also used in high-tech weapons and a wide range of electronics including smartphones, hard drives and data storage devices.

While heavy rare earths are helping to power the green transition, the way they are currently extracted presents serious environmental and social risks. Mining involves injecting chemicals into large areas of land, generates large amounts

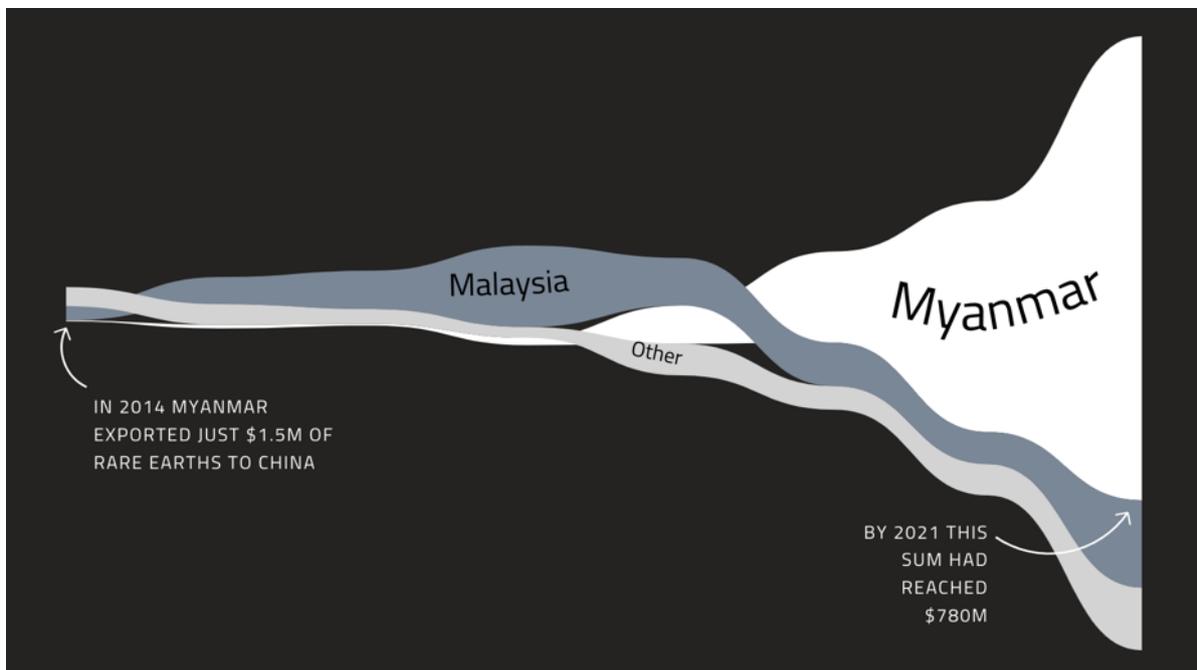
of waste and releases toxins into the air, soil, and water.<sup>1</sup>

As the world's main producer of heavy rare earths since the 1980s, China has mostly borne the environmental burden of their extraction.<sup>2</sup>

But over the last decade more and more heavy rare earth mining operations in China have been shut down as the government tightens its regulatory framework, clamping down on illegal mining and putting safeguards in place to protect against the worst environmental harms.<sup>3</sup>

Yet global demand is still growing rapidly,<sup>4</sup> and China remains the world's largest processor.<sup>5</sup> With many of its own mines now closed, where is China's supply of these minerals coming from?

An investigation by Global Witness has found that as illegal and harmful mining operations have closed in China, **heavy rare earth mining operations and their attendant environmental and social harms have been outsourced to**



Exports of rare earths from Myanmar to China have risen rapidly in recent years

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**neighbouring Myanmar, which has now become the world's largest source of supply.**<sup>6</sup>

This briefing on our findings is written in two parts.

The first part outlines the links between rare earth mining, conflict and environmental, social and governance risks in Myanmar, which has been run by a brutal military regime since a coup in February 2021 and explains how heavy rare earths from Myanmar reach international markets.

The second part recommends actions that governments and companies in consumer countries should take to ensure that the green transition does not fuel environmental and social harms in Myanmar and sets out recommendations for building more sustainable global supply chains for heavy rare earths.

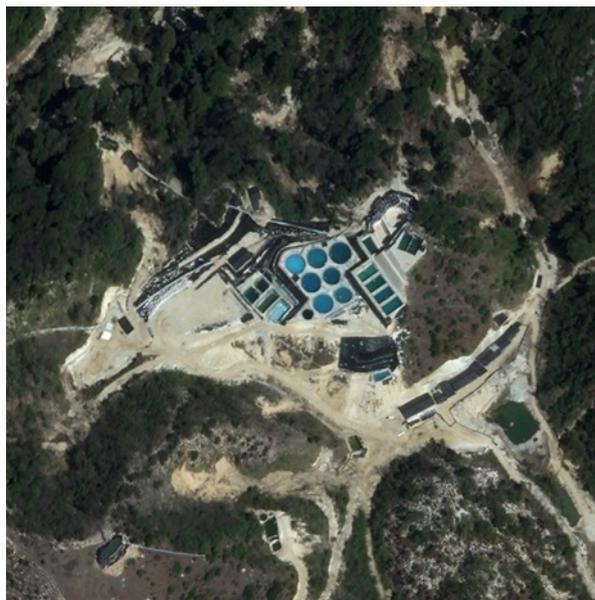
## **PART I: HEAVY RARE EARTH SUPPLY CHAINS ARE HIGH-RISK**

**“We find ourselves in the position today where there is a horrific situation going on in Myanmar, and people are questioning whether these materials are any better than, say, cobalt out of the Democratic Republic of the Congo”**

Rare earth industry expert<sup>7</sup>

### **A booming industry, controlled by armed actors**

China has been by far the largest player in the global rare earth industry since the 1980s.<sup>8</sup> But as the industry in China boomed, the cracks began to show – illegal mining was rampant, the environment was suffering and there were concerns over dwindling resources, particularly of heavy rare earths.<sup>9</sup>



Satellite image of a rare earth mine in Kachin, Myanmar. Photo Credit: © Planet Labs PBC, CC BY-NC-SA 2.0

From 2016 the central government intensified efforts to clean up the industry and closed many of the heavy rare earth mines in Ganzhou in Jiangxi Province, known as China's “rare earth kingdom”.<sup>10</sup>

This meant that China's state-owned processors needed new sources of raw materials to continue supplying the global market. They turned to neighbouring Myanmar, where there are rich deposits similar to those in Jiangxi. Thousands of people crossed the porous border to set up and work in the new mines,<sup>11</sup> bringing with them the money, technology and equipment they needed to keep supplying cheap materials to the state-owned processors back in China.<sup>12</sup> According to one report, as many as 16,000 people had migrated to Myanmar from Ganzhou by 2019.<sup>13</sup>

Almost all heavy rare earths in Myanmar are mined in a mountainous, semi-autonomous territory on the country's north-eastern border with China. Known as Kachin Special Region 1, this region is run by an ageing local warlord called Zakhung Ting Ying<sup>14</sup> who controls several

militias including a Border Guard Force that is part of the Myanmar military's chain of command<sup>15</sup> – the same military that stands accused of the gravest crimes under international law, including genocide.<sup>16</sup>

A few years ago, there were just a handful of rare earth mines in Kachin Special Region 1.

In March 2022, Global Witness commissioned a satellite to fly over the region. We found over 2,700 mining collection pools at almost 300 separate locations sprawling across an area the size of Singapore.

### **Chinese-backed rare earth mining in Myanmar is illegal**

The industry in Myanmar is highly organised, with each site typically run by a Chinese manager<sup>17</sup> and employing between 30 and 100 people.<sup>18</sup>

Chinese workers make up at least a quarter of the workforce at each mine<sup>19</sup> and hold the skilled roles while Burmese workers do most of the manual labour.<sup>20</sup>

The problem is that the Chinese-driven boom in rare earth mining is illegal under Myanmar's laws.<sup>21</sup>



Workers operate Chinese-made machinery at a rare earth mine in Myanmar's Kachin State. Photo credit: © Global Witness/supplied

Foreign investment in small- and medium-scale mineral production, like the rare earth mines in Kachin Special Region 1, is forbidden under the country's Foreign Investment Law and related legal notifications.<sup>22</sup> Foreign companies can apply to the Myanmar Investment Commission (MIC) for an exemption<sup>23</sup> but the MIC has not issued any permits to mine rare earths.

Domestic companies can mine rare earths with permission from Myanmar's natural resources ministry, but the ministry has only ever issued permits to two companies. Both were for small-scale mining, for a period of six months, and both expired in 2019.<sup>24</sup>

Zakhung Ting Ying legally owns several companies that together with companies owned by members of his family, commanders of units in his Border Guard Force and leaders of other militias under his authority, form a network of Myanmar-registered businesses<sup>25</sup> that ostensibly run the rare earth mines.<sup>26</sup> But we found these businesses are typically just fronts for Chinese beneficial owners.<sup>27</sup>

Zakhung Ting Ying and militia leaders under his authority also profit from multiple ancillary activities, most of which are illegal, according to local sources.

They allegedly confiscate land from local people and sell it to Chinese investors in breach of Myanmar's land laws, and issue informal permission for companies to mine, even though legally this should be done by the state.<sup>28</sup> They bypass immigration rules to issue unofficial permits for Chinese workers<sup>29</sup> and they issue local miners with ID cards that allow them to work at the mines.<sup>30</sup>



Zakhung Ting Ying has used his power to become phenomenally rich, overseeing vast business interests from logging to opium plantations. Photo credit: © China Photos/Getty Images

They extort fees at checkpoints surrounding the mines,<sup>31</sup> and they also control border trade, illegally taxing exports of rare earths to China.<sup>32</sup>

Even before the 2021 coup, Zakhung Ting Ying and his militia leaders were operating illegal rare earth mines with impunity,<sup>33</sup> despite attempts at a clampdown by the civilian National League for Democracy government led by Aung San Suu Kyi.

In late 2018, the civilian government banned rare earth exports to China<sup>34</sup> and subsequently introduced a “winding-down period” in which Chinese enterprises were supposed to hand back control of mining operations.<sup>35</sup> In 2019, the government sent an inspection team to Kachin Special Region 1<sup>36</sup> after more than 850 indigenous people signed a petition to the speaker of Myanmar’s parliament and the military’s Commander-in-Chief calling for illegal mining to stop.<sup>37</sup>

The Kachin State natural resources minister – who has since been imprisoned by the military junta on political charges – concluded in a report on the inspection team’s findings that there were “hundreds of illegal mining sites”.<sup>38</sup> Nevertheless, mining and trade both continued.

Since the 2021 military coup, without any kind of civilian oversight, rare earth mining operations have been expanding fast. Meanwhile Myanmar’s parallel National Unity Government, formed of elected lawmakers and other legitimate representatives in exile, has declared all rare earth mining operations illegal because they finance the military regime.<sup>39</sup>

### Links to serious human rights abuses

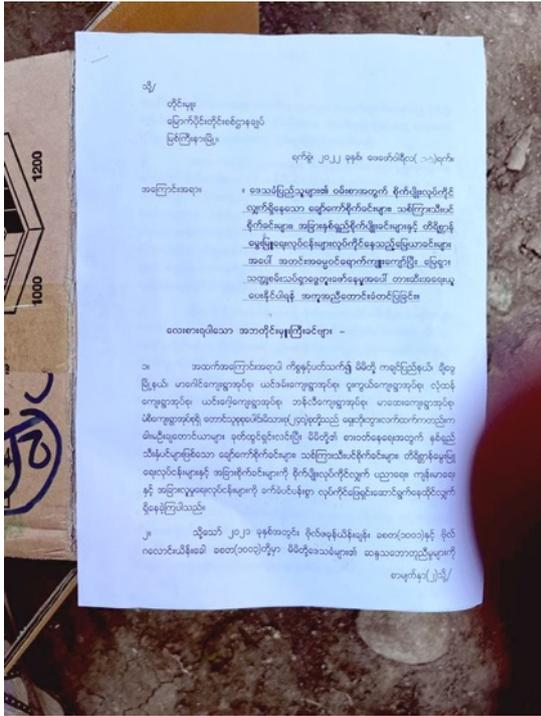
Since staging a coup, Myanmar’s military has been accused by the United Nations of committing “appalling violations”, including widespread and systematic attacks against civilians that may amount to crimes against humanity.<sup>40</sup>

Because profits from rare earth mining in Myanmar disproportionately benefit armed militias that are units in Myanmar’s military, there is a risk that they are being passed up through the command and used to fund ongoing abuses against civilians across Myanmar.

At the mining sites, while many residents oppose the mining<sup>41</sup> they are denied the right to speak out.<sup>42</sup> People who have dared to voice their opposition publicly have been threatened with violence,<sup>43</sup> while civil society groups said they find it almost impossible to operate in the area.<sup>44</sup>

Global Witness and civil society groups have gathered testimonies of intimidation, including:

- > “No-one wants to give up their ancestors’ lands, but if they [resist] they can be killed” – Kachin civil society group member<sup>45</sup>
- > “Five responsible people from five villages appealed to militia leaders and respected seniors from the Border Guard Force (BGF) in Pangwa to stop mining but were refused and threatened.” – Survey by local civil society groups<sup>46</sup>



Protest letter from villagers to Myanmar’s military. Photo credit: © Global Witness/supplied

> “We want to control it [rare earth mining], but we do not have an opportunity to do so. If we say something, whether right or wrong, they beat us.” – Community representative<sup>47</sup>

In February 2022 community leaders wrote to the commander of the military’s Northern Command, which has ultimate control over Zakhung Ting Ying’s militias, asking the commander to intervene and stop the expansion of rare earth mining. They explained in the letter that they had made the complaint after a militia leader had threatened to shoot them if they refused to give up their land.<sup>48</sup>

**“You, village leaders, should solve this issue [of villagers refusing to give up their land]. Otherwise, I will have to start shooting and killing people from now on. Do not underestimate me. I am not a child. This is not child’s play.”**

Militia leader Galaw Ying Hkaw

Without basic freedoms or protections for communities in and around the mining areas, there is a high risk that sourcing heavy rare earths from Myanmar will drive further human rights abuses.

**Links to labour-related risks**

As the mining area expands and land once used for farming is seized or becomes unprofitable due to pollution or restricted access, some local people have little choice but to become daily wage workers in the mines.<sup>49</sup> There are multiple labour-related risks for workers, including a lack of adequate protective equipment.<sup>50</sup> Workers say they are not given sufficient information about the chemicals they must use.<sup>51</sup> Their work entails other risks including landslides,<sup>52</sup> with reports that workers have died,<sup>53</sup> and we also received reports of the widespread use of child labour.<sup>54</sup>

**Links to environmental harms**

In Jiangxi, where many mining operations remain closed,<sup>55</sup> Chinese officials have estimated that the environmental clean-up will cost 38 billion yuan (around US\$5.5 billion), and a full recovery is expected to take as long as 100 years.<sup>56</sup>

In Myanmar, where the industry is illicit and controlled by armed groups, and where it is dangerous for civil society groups to operate, nobody has quantified the environmental cost. However, our investigation revealed that the impacts of mining on local ecosystems, livelihoods and access to water have been devastating.

The mining method used, known as in-situ leaching, involves removing vegetation and drilling holes into the mountains, then injecting a solution of ammonium sulphate into the holes, to dissolve the rare earth ions from the rock. Once the liquid has percolated through the mountainside, it is drained into collection pools,

where the rare earth minerals are precipitated out.<sup>57</sup> When a mountain has been leached, the chemical-filled pools are abandoned without rehabilitation.<sup>58</sup>

A survey of almost 100 people living near the rare earth mines in Kachin Special Region 1 conducted in 2018 found that local people had not used watercourses near the mines for four years because mining companies were releasing contaminated wastewater into streams around the mines.<sup>59</sup>

Moreover, survey respondents said that animals, including livestock, had been poisoned by the toxic water.<sup>60</sup> This is particularly concerning because the mountains in Kachin Special Region 1 are rich in biodiversity, being home to dozens of rare and endangered plant and animal species,<sup>61</sup> including red pandas and gibbons.<sup>62</sup>

Local sources told Global Witness in 2022 that the rivers remain contaminated and that most of the fish, birds, and animals are gone.<sup>63</sup> They said local people continue to struggle to access drinking water<sup>64</sup> and farmers cannot grow crops near the mines.<sup>65</sup> Several years ago, locally grown black cardamoms and quinces found plenty of buyers across the border. Now, however, Chinese traders refuse to buy agricultural products grown near the mining sites, villagers said.<sup>66</sup>

Multiple health issues have been reported in China because of in-situ leaching, including osteoporosis, respiratory diseases, and gastrointestinal, skin and eye problems.<sup>67</sup>

Another major concern is that contaminated watercourses near the mines flow directly into the N'Mai Kha River, a tributary of the Ayeyarwady,<sup>68</sup> Myanmar's most important river, whose basin is home to two-thirds of the country's population of 54 million people.<sup>69</sup> Just as in China, where Jiangxi Province is home to



A view over the rare earth mines carved into the mountains in Kachin State, Myanmar. Photo credit: © Global Witness/supplied

two rivers that provide drinking water to millions of Chinese living as far downstream as Hong Kong,<sup>70</sup> there are fears that the contamination could spread downstream.<sup>71</sup>

### **How rare earths from Myanmar enter global supply chains**

Heavy rare earths mined in Myanmar are partially processed near the mines<sup>72</sup> and then trucked from Pangwa across the border to Yunnan Province<sup>73</sup> and transported within China to the state-owned enterprises that control 80% of global rare earth refining.<sup>74</sup>

All the heavy rare earths mined in Myanmar are exported to China and even though rare earth mining in China has slowed, the country still controls almost all the world's processing facilities.<sup>75</sup>

Just five state-owned companies have a monopoly on mining and processing heavy rare earths (a sixth company mines and processes only light rare earths)<sup>76</sup> and these five companies have been merged or are set to be acquired over the next few years [to form a single group](#).<sup>77</sup>



Bags of rare earth are piled up at a mine to be processed before being exported to China. Photo credit: © Global Witness/supplied

Among them, the biggest player is China Southern Rare Earth with over 40% of the officially sanctioned mining quota.<sup>78</sup>

However, it is not clear how much mining the company is actually doing. China does not publish production figures, while research by a Chinese customs official states that China Southern imports 70% of its raw materials from Myanmar and gets the other 30% from recycling.<sup>79</sup>

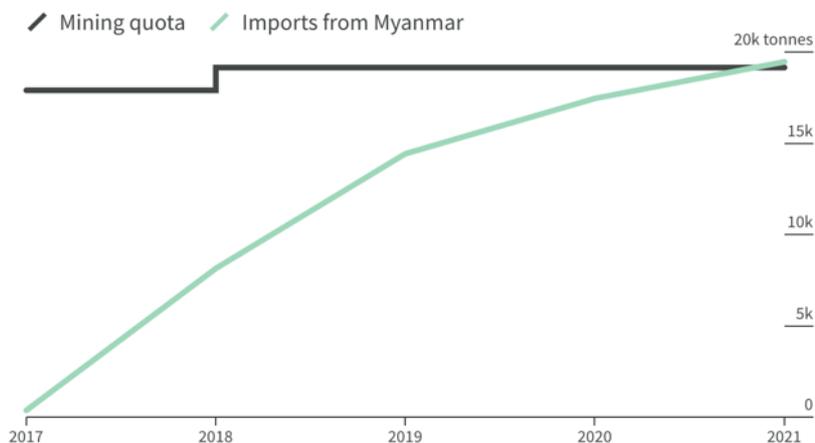
That China Southern is sourcing rare earths from Myanmar is supported by a 2021 post its website, which says that its parent company Ganzhou Rare Earth Group “has taken the lead in opening up the path of importing rare earth resources from Southeast Asian countries such as Myanmar”, and “has seized more than 50% of overseas rare earth resources” and “imported 10,000 tons of... rare earth raw ore” after Ganzhou’s rare earth mines were closed over environmental concerns.<sup>80</sup>

While there is very little public information linking China’s other state-owned companies to Myanmar’s illegal mines, we also uncovered a range of evidence indicating that at least two of the other four heavy rare earth processing giants – China Minmetals Rare Earth Company and Guangdong Rare Earth Group<sup>81</sup> – have been sourcing from Myanmar.

Imports from Myanmar now exceed China’s domestic mining quotas, so even if the mines in China were producing at full capacity, Myanmar would remain the country’s single largest source

### Imports surpass quota

Imports from Myanmar surpassed China's quota for heavy rare earth mining in 2021



Source: GACC/MIIT

of new heavy rare earth supply – and with no other companies in China legally allowed to process this material, there is nowhere else for imports to go.

With domestic stockpiles dwindling, Chinese enterprises are increasingly dependent on supply from Myanmar.<sup>82</sup>

As commodity research firm Roskill wrote in a September 2021 report, “All Chinese state-owned enterprises (SOEs), except for those [that] focus on light rare earths, have become reliant on Myanmar sources over the past four years, and now face supply chain risks with few alternative suppliers.”<sup>83</sup> This leaves not only Chinese processors but the entire global permanent magnet industry highly vulnerable to supply chain shocks.

**“Myanmar has become such an important supplier that it would be very tough to increase quotas sufficiently to fill that gap.”**

Ryan Castilloux, Adamas Intelligence<sup>84</sup>

Once they are processed by China's state-owned companies, Myanmar's rare earths pass down the supply chain to permanent magnet manufacturers, meaning that heavy rare earths from Myanmar are likely to end up in these companies' products.

We followed the supply chain of one the largest magnet makers, JL Mag Rare-Earth Company, finding that it sources some of its heavy rare earths through a long-term supply agreement with China Southern<sup>85</sup> and supplies permanent magnets to some of the world's best-known manufacturers of electric vehicles, wind turbines and electronics.

JL Mag's customers include automotive manufacturers BYD, General Motors, Li Auto,



People walk past a Tesla dealership in Shanghai, China. Photo credit: © Qilai Shen/Panos Pictures

Nidec, NIO, SAIC Motor, Tesla, United Automotive Electronic Systems and Volkswagen, electrical appliance companies Gree Electric, Midea and Mitsubishi Electric and wind turbine manufacturers Goldwind and Siemens Gamesa.<sup>86</sup>

We wrote to all the companies and individuals named in this investigation to give them an opportunity to comment on the record, and three of them replied.

Siemens Gamesa said it recognised that rare earth mining comes with “significant environmental and social risks” that the company is trying to mitigate, including by phasing out heavy rare earths from its products. It said initial feedback from its suppliers indicated they only sourced from China.

Nidec Corporation and Robert Bosch GmbH, which both buy permanent magnets containing dysprosium and terbium from JL Mag, said that they only source products containing recycled rare earth. Nidec said that China Southern supplies 100% recycled rare earth products to JL Mag, and that it believed the magnets being used for its products were unrelated to mining in Myanmar, but that it would look further into the matter. JL Mag did not respond to our request for comment.

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Even if companies are buying recycled rare earth products, there is a risk these products will be “contaminated” with heavy rare earth from Myanmar because materials from various sources get mixed together during processing, a rare earth industry expert told Global Witness.

“If you’re buying magnets, particularly the high-grade magnets more reliant on heavy rare earths, there’s a good chance some amount of material has come from Myanmar,” he said.<sup>87</sup>

## **PART II: RECOMMENDATIONS**

### **Preventing heavy rare earths mined in Myanmar from entering global supply chains – recommendations to companies and governments**

Rare earth mining in Myanmar is a particularly egregious example of the harms caused by an unregulated and exploitative extractive industry. Urgent action is needed across the entire supply chain to ensure that communities and the environment in Myanmar are protected as companies and governments ramp up investment in critical minerals.

#### **Recommendations to companies**

##### ***To companies mining, or planning to mine, heavy rare earths in Myanmar***

1. Halt mining operations, in recognition that they violate Myanmar law and international norms.
2. Do not apply for mining licences, in recognition that the military regime is not a legitimate government and legal and responsible mining is presently not possible in Myanmar.

##### ***To companies whose supply chains involve heavy rare earths***

1. Comply with all relevant international norms and domestic laws, including those governing the illicit trade in

resources, as well as with economic and trade sanctions.

2. Adopt and apply the OECD’s Due Diligence Guidance for Responsible Supply Chains of Minerals from Conflict-Affected and High-Risk Areas (OECD Guidance), including by implementing the OECD’s five-step framework for risk-based due diligence. Companies following the OECD Guidance should conclude that responsible sourcing of heavy rare earths from Myanmar, including through processers in China and other third countries, is impossible in the current context and disengage responsibly.
3. Apply the OECD five-step framework to pre-existing stocks of heavy rare earths from Myanmar, or of products made from those rare earths to the extent that it is possible to identify the source of existing supplies.
4. Take responsibility for supply-chain due diligence by not relying on third-party validations to ensure compliance.

##### ***To financiers and investors in companies that mine, process, or source rare earths***

1. Develop an engagement plan to ensure that companies in receipt of investment are not contributing directly or indirectly to harms related to heavy rare earth mining in Myanmar.
2. Make public reporting on sourcing a requirement of financial support or investment.
3. Use leverage, such as the threat of withdrawing financial support, to dissuade companies from continuing to source, directly or indirectly, heavy rare earths from Myanmar.

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### ***To industry bodies, including the Rare Earth Industry Association***

1. Develop detailed guidelines aligned with the OECD Guidance and ensure members adhere to them.

### **Recommendations to governments**

While codes of conduct, guidelines and industry standards are helpful corporate frameworks, voluntary measures governing mineral supply chains have failed to substantially change harmful corporate behaviour and protect affected communities and the environment. Stronger action is needed to ensure that unregulated markets do not undermine the just transition towards a green and equitable global economy. Governments should:

1. Adopt import restrictions for rare earth elements produced in Myanmar or produced by a list of designated entities presumptively barring them from entry unless the importer can present clear and convincing evidence that the product has not been linked to human rights abuses and corruption and the product was produced legally.
2. Adopt targeted sanctions against Zakhung Ting Ying, his immediate family, and the leaders of the militias under his authority, to prevent armed actors that are units in the Myanmar military and provide it with support from profiting from the trade.
3. Enshrine the OECD Guidance in law, promote awareness of it and ensure compliance by companies subject to their jurisdiction, imposing penalties on those that fail to conduct adequate supply chain due diligence, mitigation and remediation.

4. The European Union should ensure that the Corporate Sustainable Due Diligence Directive becomes an effective mechanism and is not undermined by reliance on ineffective third-party verification systems, weak transparency and disclosure requirements, and the absence of meaningful stakeholder engagement.
5. Governments should adopt legislation similar in substance to the EU's Corporate Sustainable Due Diligence Directive in other key markets for rare earths and other critical minerals.
6. Incorporate conflict-sensitive supply chain due diligence into national action plans on business and human rights and adopt these plans into domestic legislation with adequate penalties and incentives, ensuring that they are implemented with adequate resources and enforced.
7. Ensure national financial systems do not facilitate money laundering related to the illicit trade in heavy rare earths.

### **A fairer future: five recommendations for building sustainable supply chains for heavy rare earths**

Even as companies meet their responsibility under the OECD Guidance to stop sourcing heavy rare earths from Myanmar, there is a danger that destructive rare earth mining practices will simply be shifted to other high-risk environments in states without effective governance.

This cannot be allowed to occur. New mining projects must prioritise an equitable and environmentally responsible approach to the costs and benefits of extraction, minimising environmental damage and impacts on communities while ensuring meaningful local

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consultation and the Free, Prior and Informed Consent (FPIC) of indigenous communities. Governments must ensure that extracting companies take responsibility for remedying any impacts, and that downstream companies purchasing heavy rare earths or products that use them contribute proportionally to the costs of such measures. Meanwhile investment in design changes, substitution and recycling can greatly reduce the need for extraction, so helping to minimise its impacts.

The following five recommendations offer a vision of how the growing demand for heavy rare earths can instead be met sustainably.

### ***1. Supply chain diversification must prioritise environmental and social justice***

Global markets currently depend on China and Myanmar for most of their supply of heavy rare earths, and within those countries a few communities and environments have been disproportionately harmed. The growing global demand for heavy rare earths for use in various low-carbon technologies indicates that mining is likely to increase at least to some degree, but there needs to be greater fairness in the distribution of costs and benefits, while environmental damage should be minimised and harms to frontline communities should be avoided.

As new heavy rare earth mining and processing ventures are prospected around the world, including in Australia, Greenland and the United States, governments and companies must respect customary and indigenous land rights, including the right to FPIC, which includes the right to say no to mining projects. Governments must ensure that strong community consultation requirements, as well as environmental and

labour regulations, are both in place and enforced.

### ***2. Companies must be responsible for rehabilitation and governments must hold them accountable***

The development of new mining projects should be paired with the rehabilitation of land and ecosystems that have been impacted by earlier mining projects, to ensure that new projects do not simply create a new set of environmental, social, and human rights problems, while the harms caused by ongoing operations are allowed to continue and the legacy of damage done by mines that have closed is left unaddressed.

In the case of new projects, responsibility for prevention and rehabilitation lies with extracting companies, which must establish appropriate plans that include sufficient resources before they start mining, and must then follow these plans through, while governments must hold them accountable with adequate laws.

### ***3. The price of heavy rare earths must incorporate the environmental cost of mining***

Heavy rare earth mining has been devastating for the environment in Myanmar in part because few, if any, environmental safeguards have been put in place. The environmental impact of mining is not reflected in current market prices for dysprosium and terbium, which as a result are artificially low.

As new mining projects are developed elsewhere, the costs of environmental safeguards, including processes for treating waste and recovering acids from the soil, must be factored in, rather than externalised onto neighbouring communities and ecosystems, as is happening in Myanmar.

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Companies are only likely to factor in these costs if appropriate laws are enforced with high penalties for non-compliance.

**4. Stronger recycling policies are required to minimise the need for extraction**

Improving supply chain due diligence and relocating mining operations to countries with stronger regulations and enforcement, while vital measures in themselves, will not be enough to ensure a sustainable heavy rare earth sector. The economic model of requiring a constant stream of raw materials also needs to change as we build a greener and more sustainable future.

Electric vehicle, wind turbine and other technology manufacturers are already looking at ways to integrate heavy rare earth recycling into their supply chains to reduce the need for new extraction of minerals. However, the market supply of heavy rare earths from recycling remains negligible, with most dysprosium and terbium eventually ending up in landfills when products reach the end of their lives.

Stronger government policies, including producer responsibility laws and recycling targets, are needed to accelerate research into

and investment in closed-loop supply chains. This will both reduce the inevitable harms of extraction, as demand for heavy rare earths increases, and help protect the supply chains of these critical minerals against disruption.

**5. Investment in substitution and policies aimed at lowering consumption will also reduce extraction-related harms**

In parallel with regulations promoting recycling, greater investment is needed in the process of designing heavy rare earths out of key products. Several companies, particularly electric vehicle manufacturers, are seeking to reduce their reliance on heavy rare earths, by using alternative materials. Rising prices of dysprosium and terbium owing to the incorporation of the environmental cost of production will incentivise efforts to develop substitute products, but government support is also needed to develop sustainable alternative solutions.

Government policies that seek to achieve more sustainable consumption levels will also support a reduction in demand for heavy rare earths and reduce the harms associated with mining.

## ENDNOTES

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