Smartphone Material Profiles

Opportunities for improvement in ten supply chains







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Fairphone is working to make a positive impact on material supply chains

Fairphone is a social enterprise that makes smartphones to create an impact in the electronics supply chain. One of our key focus areas is sourcing and using fair materials in our products. So far, with the support of our partners, Fairphone owners and our community, we've been able to source traceable tin, tantalum and tungsten from conflict areas in the Democratic Republic of the Congo (DRC) and Rwanda. In addition, we're sourcing Fairtrade gold from mines in Peru.

After finding more responsible sources of the four legally recognized conflict minerals, we want to expand our impact and take the next step. The research compiled in this report is intended to help shape Fairphone's upcoming materials priorities, improve transparency and consumer awareness, and inspire the rest of the industry to better understand the risks and opportunities. We encourage others to build upon what we have learned, so that together we can create a platform for taking action to improve material supply chains.

Using this report

Fairphone collaborated with The Dragonfly Initiative (TDI), to develop a framework to better understand the issues and opportunities for improving global material supply chains. Following an initial assessment of 38 materials found in smartphones and published in our Materials Scoping Study, this report summarizes the second step in our research: taking a closer look at ten priority materials. This information will provide the foundation for Fairphone's materials road map for the future. The layout of this report reflects our research process. The first pages indicate where the materials are found in our phone and where they are most commonly mined. This is followed by profiles that highlight key information about each material supply chain, including extraction, use and recycling, selected issues in producer countries and existing initiatives that are working to find solutions to these issues. For an explanation of the indicators used, please refer to the appendix. The appendix provides additional insight into the indicators used and a longer list of initiatives that are active in a variety of material supply chains.

The information contained in this report is by no means exhaustive. It is meant to serve as a high-level snapshot of opportunities and as a starting point to spark conversation and collaboration as we work together towards improving material supply chains.

Examples of the use of the ten priority materials in the Fairphone 2

1. Display Indium

2. Core Module
Copper (PCB)
Nickel (shields)
Gold (Integrated circuits)
Gallium (semiconductors)
Tantalum (tantalum capacitor)

Tin (solder, PCB)

p.	18	
р. р. р. р.	11 20 15 13 26 28	

3. Top Module Rare Earths (speaker)	p. 22
4. Camera Module	
5. Battery Cobalt	p. 10
6. Bottom Module Tungsten (vibration motor)	p.30





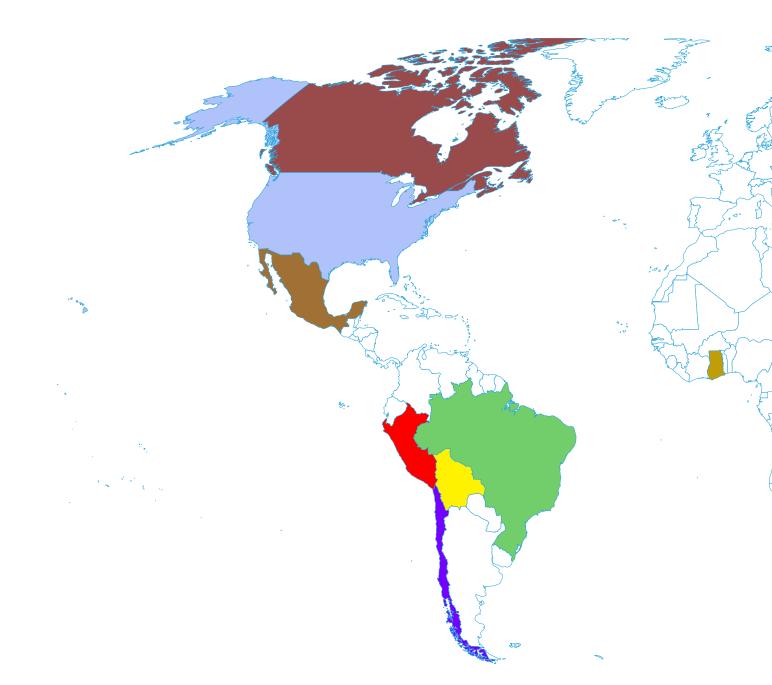
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4.

Global Mined Production



Cobalt



Gold

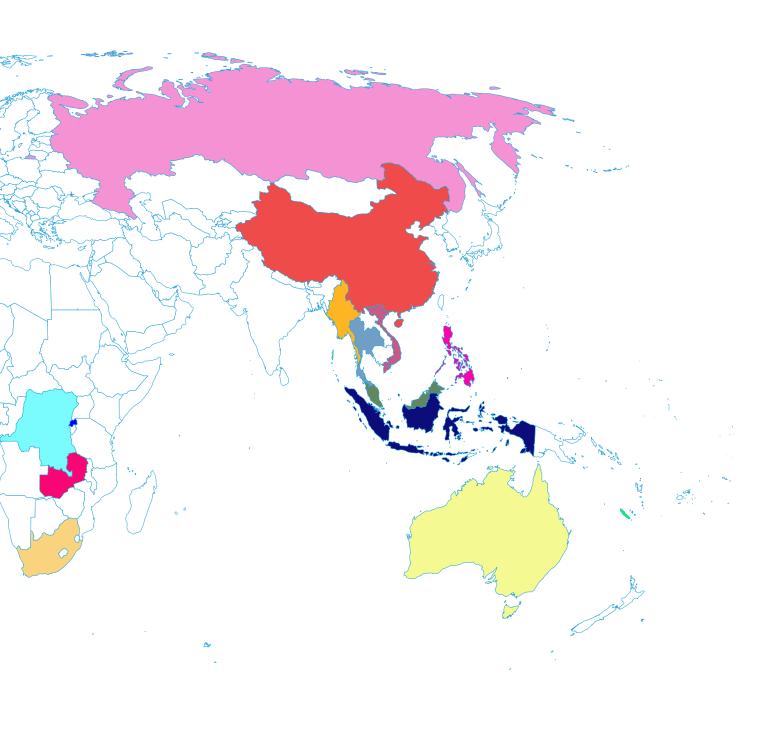


Copper



Nickel







Tungsten



Tantalum





Rare Earths

Gallium and Indium

*Data of global mined production is not available due to the fact that these are only mined as a by-product of other metal ores.

Cobalt (Co)

Key Information

Primary smartphone component in which cobalt is found	Lithium-ion battery
Other industries using this component	Electric and hybrid automotives, medical
Cobalt content in primary component	High
Other main materials in primary component	Lithium, graphite
Other main components in which cobalt is found	Speaker, traces in other components

Consumer electronics industry consumption	Very high
Criticality for smartphone functionality	High
End of life recycling rate	Very High
Estimated depletion rate	Low
Association with environmental and social issues in mining	Artisanal and small-scale mining, conflict, serious health problems, water/soil pollution, radioactive waste, significant threats to biodiversity, high CO ₂ emissions

Additional information

Cobalt is predominantly recovered as a byproduct from industrial copper and nickel operations but can also be mined using artisanal and small-scale mining (ASM). • Pressure from human rights groups and an ongoing Amnesty International campaign call for similar transparency in cobalt supply chains as those of designated conflict minerals. • Global consumption of cobalt is fast-rising due to increased demand for batteries and cobalt-based superalloys. • Green technology is becoming increasingly dependent on cobalt to extend battery life and store renewable energy more efficiently.

Top Producer Countries

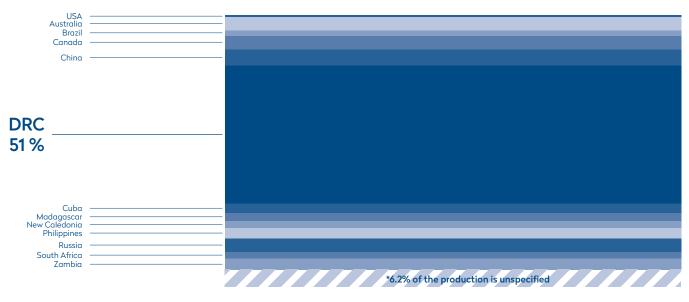
	DRC	China	Canada	Russia	Australia	Zambia
Global mined production	51%	6%	5%	5%	5%	4%
Global reserves	48%	1%	3%	4%	15%	4%
Mining sector contribution to GDP	20.3%	1.2%	0.7%	0.9%	5.8%	12.8%
Government stability and perceived effectiveness						
Peacefulness						
Quality of natural resource and environmental governance						
Transparency				•	•	
Ease of doing business						
Human development index	0.435 Low	MD	0.92 Very High	0.804 Very High	0.939 Very High	0.579 Moderate

Very Low





Cobalt Global Mined Production



Source: USGS mineral commodity summaries 2016

Selected Issues by Country

China

Industrial cobalt production has been associated with extensive heavy-metal and radioactive contamination of water and soil as well as over-exploitation of groundwater and public health issues associated with industrial pollution.

Russia

Renewed development of Russia's largest cobalt mine with Chinese investment has generated concerns regarding biodiversity of local protected areas and the traditional pastoral livelihood of indigenous groups. Norilsk is considered one of most polluted places on earth due to the Norilsk Nickel plant (now undergoing modernization) which also produces cobalt as a byproduct.

* Canada

Cobalt production in Canada is a byproduct of the nickel and copper industries, which are associated with historical environmental degradation and contamination. However progressive rehabilitation is now one of the key elements of Canadian policy for post-mine planning strategies.

📕 Zambia

Historic copper and cobalt mine waste has created a potential source of acid mine drainage. Large areas within the currently active Copperbelt mining region are contaminated with cobalt, copper and other toxic metal residues that present significant risks to public health. Mining discharge is also compromising water quality in some regions and negatively affecting local aquatic ecosystems.



In the DRC, a significant amount of cobalt is mined using artisanal and small-scale methods and can be associated with child labor and forced labor, bribery, corruption and direct and indirect support of non-state armed groups. Mining communities are exposed to dangerous levels of contaminated dust and water. Communities are also vulnerable to being forcibly relocated to resource-poor areas.

ISSUE	DESCRIPTION
End-of-life recycling rate	The overall post-consumer cobalt recycling rate is considered high, yet only a small portion of the cobalt used in consumer electronics is recycled. With consumption expected to exceed production by 2020, more efficient recycling of cobalt from electronics will become a key area for industry attention.
Unregulated artisanal and small-scale (ASM) mining practices	ASM production creates livelihoods for millions of families worldwide. Unregulated ASM can also be associated with serious social and environ- mental issues. In the DRC, cobalt is associated with the worst forms of human rights abuses, including child labor and forced labor. Alternatives to ASM or improvement of the sector should be pursued. An example of an initiative working on child labor in the DRC is the Stop Child Labour Coalition: Out of Work and into School program.

ISSUE	DESCRIPTION
Conflict	Cobalt can be linked to the direct and indirect support of non-state armed groups the DRC, and is currently under consideration as a fifth conflict mineral by several industry actors (in addition to gold, tantalum, tin and tungsten). The industry could benefit from a sector-specific initiative to drive best practices on avoiding and managing potential conflict. Initiatives could leverage the lessons from other sectors such as 3Ts. Emergent initiatives in this areas include the Responsible Cobalt Initiative (RCI) and the Responsible Raw Materials Initiative (RRMI).
Serious health issues, especially respiratory illness	Cobalt is extracted from ores that generate hazardous airborne pollutants that threaten worker and community health when not managed responsibly, both in industrial and informal mining contexts. Inhalation of cobalt dust is a primary cause of hard metal lung disease in the DRC. An example of an initiative working on this issues is the Center for Effective Global Action (CEGA).
Radioactive waste	Cobalt can often be found in the same geological deposits as Naturally Occurring Radioactive Materials (NORM). Where mine waste is not adequately stored it can present a serious health risk, for example in China where mining has led to radioactive contamination of local ecosystems. The responsible management of radioactive waste can be addressed by specific (best-practice) standards or individual companies, but could require more attention by industry.
Water and soil pollution	Cobalt can occur in acidic sulfide ores, leading to risk of acid mine drainage and leaching of toxic heavy metals into local ecosystems. Fast-growing mine economies such as China present significant risk because they may develop without adequate infrastructure for waste management. While water and soil pollution can be addressed by specific (best-practice) standards or individual companies, it could require specific monitoring mechanisms and attention to address the long-lasting effects on communities.
Serious impacts on biodiversity	Where mined together with copper in large-scale industrial projects, cobalt mining can leave large footprints on local landscapes and ecosystems, particularly when not managed or rehabilitated responsibly, as in China. Widespread unregulated ASM can have equally negative effects requiring more attention.
CO ₂ emissions	Cobalt is associated with significant levels of $\rm CO_2$ emissions due to energy intensive processing from extraction through to smelting.

Copper (Cu)

Key Information

Primary smartphone component in which copper is found	Printed circuit board (PCB)
Key industries which use this component	Automotive, aeronautics, toys
Copper content in primary component	High
Other main materials in primary component	Gold, nickel
Other main components in which copper is found	Connectors, integrated circuits, flexible printed circuits, many other components

Consumer electronics industry consumption	High
Criticality for smartphone functionality	Very high
End of life recycling rate	Very high
Estimated depletion rate	Moderate
Association with environmental and social issues in mining	Artisanal and small-scale mining, conflict, serious health problems, water and soil pollution, radioactive waste, significant biodiversity threats, high $\rm CO_2$ emissions

Additional information

Copper mining interests in the minor producing countries of Myanmar and Zambia have been linked with reported human rights abuses by Amnesty Int. and Human Rights Watch. • Much open-pit copper mining is now moving underground to tap higher grade ores. • Copper is also associated with experimental sea bed mining in the South Pacific ocean.

Top Producer Countries

	Chile	China	Peru	USA	DRC	Australia
Global mined production	30%	9%	8.5%	6.5%	5%	5%
Global reserves	29%	4%	11%	5%	3%	12%
Mining sector contribution to GDP	14.2%	1.2%	6.2%	0.1%	20.3%	5.8%
Government stability and perceived effectiveness						
Peacefulness	•					
Quality of natural resource And environmental governance			•			
Transparency			•	•		
Ease of doing business	•					
Human development index	0.847 Very high	MD	0.740 High	0.92 Very High	0.435 Low	0.939 Very high





Selected Issues by Country

Peru

Copper production has doubled in the last 5 years, leading to depletion of water resources in the Andes. Peru's Human Rights Ombudsman ranks industrial mining as the top cause of conflict due to environmental concerns and lack of job generation. The sharp rise in violent conflict from 2015 onwards is strongly associated with industrial copper mines, with multiple cases of mine-protester deaths from police attacks as recently as November 2016.

USA

Copper mining is associated with historical environmental disruption and water pollution in the USA and has also caused radioactive contamination of surface soil and groundwater when mined from uranium-rich deposits such as those in Arizona.

Le Chile

Copper mining is associated with depletion of water resources in one of the world's most arid regions - the Atacama desert, as well as poor air quality and poor respiratory health in worker camps. Falling ore grade is leading to increased focus on mine reconversion projects, projected to happen over the next 10 years.

China

Extensive water contamination in the Ting River basin has been caused by wet copper smelting (and gold heap leaching) of low grade ores combined with poor tailings storage. Copper mining is also at the root of Yueyang's "cancer villages" caused by toxic air pollution and water contamination by heavy metals.

🔀 drc

Copper occurs together with cobalt in the DRC and can be, when mined together with cobalt, associated with direct and indirect support of armed groups. A significant proportion of copper and cobalt is mined by unregulated ASM, where working conditions are often poor and miners face considerable health risks, including inhalation of heavy metal dusts. China has signed a deal with the DRC's state copper company to exchange infrastructure for resources.



Copper mining is associated with historical deforestation and soil erosion.

ISSUE	DESCRIPTION
Depletion rate	Copper could become unavailable from mining within 1000 years, making recycling increasingly important. PCBs contain a range of metals, offering opportunities for combined recovery efforts. Initiatives for increased recycling opportunities include bio-leaching of gold from PCBs, Electronic Recycling for a Circular Economy (ERICE) and ReUSE Alternative PCB Technology.
Unregulated artisanal and small-scale (ASM) mining practices	ASM production creates livelihoods for millions of families worldwide. However, unregulated ASM can also be associated with serious social and environmental issues. For example, in the DRC, copper mining has been associated with the use of child labor.
Conflict	Copper, where mined together with cobalt, can be linked to the direct and indirect support of non-state armed groups the DRC. In Peru, it is also directly linked to conflict between mining companies and local communities. In these contexts, there could be an opportunity for improving community consultation, participation and dialogue.
Serious health issues, especially respiratory illness	Copper is extracted from ores that are known to generate hazardous airborne pollutants that threaten worker and community health when not managed responsibly, both in industrial and informal mining contexts. South American copper-containing ore can also be rich in arsenic, presenting additional health risks.
Water and soil pollution	Copper can occur in acidic sulfide ores, leading to risk of acid mine drainage and heavy-metal leaching if not managed properly. Fast-growing mine economies such as China pose significant risk if they develop without adequate waste management infrastructure in place. Specific measures may be required to address the long-lasting effects on communities.
Radioactive waste	Copper is often found alongside Naturally Occurring Radioactive Materials (NORM) for example in Arizona, USA, where it is found in uranium-rich rock. This presents the risk of radioactive particles seeping into surrounding soil and water systems. The responsible management of radioactive waste could benefit from more collective industry attention.
Serious impacts on biodiversity	Large-scale industrial copper mining projects leave large footprints on local landscapes and ecosystems, particularly when not managed or rehabilitated responsibly, as in China. Widespread unregulated ASM can have equally negative impacts.
High CO ₂ emissions	Copper is associated with high levels of CO ₂ emissions due to energy- intensive processing from extraction through to smelting.

Gallium (Ga)

Semiconductors

Key Information

Primary smartphone component where gallium is found	Semiconductors
Other key industries which use this component	Renewable energy
Gallium content in primary component	Low
Other main materials in primary component	Silicon, nickel, palladium, gold
Other main components in which gallium is found	Trace amounts in other components

Consumer electronics industry consumption	Very high
Criticality for smartphone functionality	Very high
End of life recycling rate	Very low
Estimated depletion rate	Very low
Association with environmental and social issues in mining	Serious radioactive waste, high $\rm CO_2$ emissions, significant biodiversity threats, serious health issues

Additional information

Gallium is one of world's rarest minerals because it does not exist as a free element in the Earth's crust – only in trace amounts in other metal ores – primarily bauxite. • Gallium is extracted as a byproduct during the processing of other mineral ores, predominantly alumina, and a small amount from zinc processing. • Gallium supply is vulnerable due to its supply being driven by different markets than those that drive the industries which create it as a byproduct. Supply is also vulnerable to the Chinese market and regulation. • Gallium is also recovered from metal-processing scrap. • Gallium is sometimes substituted by indium, however indium is associated with similar supply issues.

Top Producer Countries

	China	Germany	Japan	Ukraine
Global mined production	Majority*	Minority*	Minority*	Minority*
Global reserves	MD*	MD*	MD*	MD*
Mining sector contribution to GDP	1.2%	0.0%	0.0%	3.1%
Government stability and perceived effectiveness	•			
Peacefulness				
Quality of natural resource and environmental governance				
Transparency	•		•	•
Ease of doing business	•	•	•	•
Human development index	MD	0.926 Very High	0.903 Very High	0.743 High

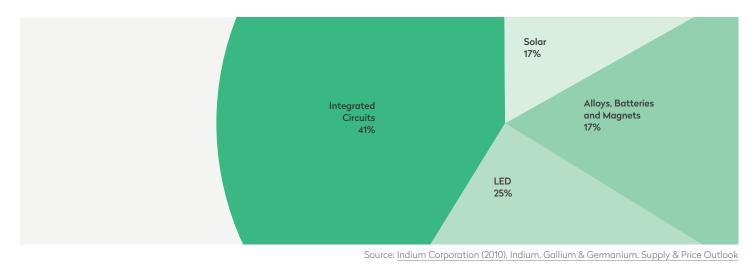
*Data not available due to the fact that gallium is not found in elemental form.

Very Low





Use of Gallium by Sector



Selected Issues by Country

Information on the issues associated directly with gallium production is limited due to gallium being a byproduct of other mineral processes. Therefore, the issues identified are those associated with bauxite extraction and processing, the primary ore in which gallium is found.

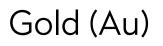
China

There have been large-scale spillages of toxic "red mud" waste reportedly linked to bauxite refining processes due to poor storage and tailing dams overflowing – causing environmental degradation, displacement of communities and reported mortalities. Many mines were closed in 2016 due to poor environmental regulation that has led to widespread water and soil contamination and risks to public health.

Ukraine

There are some reports of "red mud" spillages creating environmental and health hazards, similar to China.

ISSUE	DESCRIPTION
Critical for smartphone functionality	Gallium performs a function in smartphones that cannot yet viably be performed by any other material without significantly compromising performance quality. Industry research into alternative materials and technologies is ongoing.
End-of-life recycling rate	The supply of gallium is uncertain because it is a by-product of other mineral processing, making recycling of gallium an important area for industry action. It is estimated that less than 1% of gallium is currently recycled from post-consumer waste, requiring further attention.
Serious health issues	Gallium can be extracted from ores that are known to generate hazardous airborne pollutants when not managed responsibly, which can cause a variety of respiratory illnesses. While the issue can be addressed properly by individual companies and (best-practice) standards, it is an issue that could generally benefit from more attention. Individual companies, mine workers and the surrounding communities could benefit from better monitoring and specific industry action.
Radioactive waste	As a byproduct of bauxite processing, which often occurs concurrently with Naturally Occurring Radioactive Materials (NORM), gallium could be associated with instances of radioactive contamination from mine waste that is not managed responsibly, as in China.
Serious impacts on biodiversity	Gallium is a byproduct of the bauxite refining process and bauxite mining can leave large footprints on local environments and ecosystems, particularly in tropical latitudes where it has been the cause of extensive deforestation, as in Jamaica.
High CO ₂ emissions	Gallium is associated with high levels of CO ₂ emissions because it is a byproduct of the energy-intensive bauxite-alumina-aluminum process.



Integrated Circuits

Key Information

Primary smartphone component where gold is found	Integrated circuits
Other key industries which use this component	Automotive, aeronautics, toy industry
Gold content in primary component	Low
Other main materials in primary component	Silicon, tin, copper
Other main components in which gold is found	Connectors, printed circuit board, many other components

Consumer electronics industry consumption	Low
Criticality for smartphone functionality	Low
End-of-life recycling rate	High
Estimated depletion rate	Very high
Association with environmental and social issues in mining	Artisanal and small-scale mining, conflict, serious health problems, radioactive waste, water and soil pollution, use of toxic chemicals, significant threats to biodiversity, high $\rm CO_2$ emissions

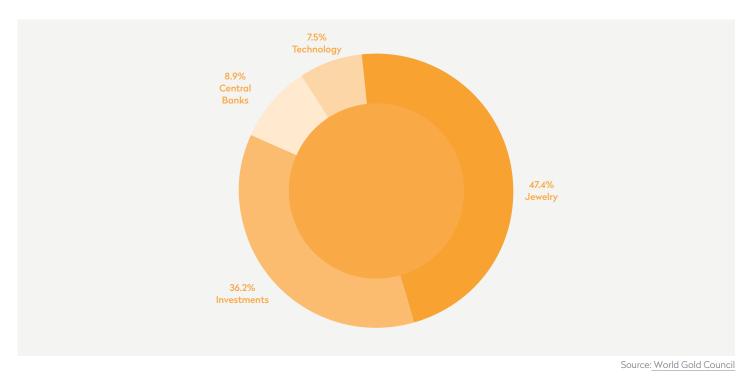
Additional information

• Although the end-of-life recycling rate for gold is very high for most post-consumer waste, it remains very low for electronic products. This is because of limited collection rates and because the tiny amount of gold in electronic devices is costly and labor-intensive to remove. • Efforts for gold ASM certification are underway and intensifying in South America, East and West Africa, and Southeast Asia. • In 2016 Madagascar exported gold for the first time from ASM, attracting interest in investment, formalization and verification systems.

Top Producer Countries

	China	Australia	Russia	USA	South Africa	Peru	Mexico	Ghana
Global mined production	16%	10%	8%	7%	5%	5%	4%	3%
Global reserves	3%	16%	14%	5%	11%	5%	3%	2%
Mining sector contribution to GDP	1.2%	5.8%	0.9%	0.1%	3.3%	6.2%	0.7%	6.5%
Government stability and perceived effectiveness								
Peacefulness								
Quality of natural resource and environmental governance		•						
Transparency			•	-		•		
Ease of doing business								
Human development index	MD	0.939 Very High	0.804 Very High	0.92 Very High	0.666 Moderate	0.740 High	0.762 High	0.579 Moderate
Very Low		Moderate	•	High		Very High	MD	/issing Data

Gold Demand by Sector (2016)



Selected Issues by Country

China

Gold is a fast-growing industry in China, often leading to inadequate infrastructure that is associated with poor health and safety in underground mines, high risk of respiratory disease (silicosis), toxic water and soil contamination.

≽ South Africa

Informal gold mining in South Africa is associated with poor health and safety, high risk of respiratory disease (silicosis), toxic water and soil contamination. There is currently a class action suit against a large scale gold mining companies to compensate mine workers for occupational health issues that could affect up to 200,000 workers, dating back to the 1960s.

Peru

Gold is Peru's most significant illicit export, and informal ASM is strongly associated with human rights abuses, such as child labor, sexual exploitation and trafficking. ASM gold mining is also associated with widespread environmental degradation and deforestation as well as intensive mercury usage which creates serious health risks and risk of water contamination. There are disputed land use claims in indigenous and rural communities bordering gold mining areas and rising incidence of corporation-community conflict and anti-mining activism at LSM sites.

Russia

The ban on dredge mining in China has caused a growth in gold dredging in Russia, which can be associated with mercury contamination.

Mexico

Informal gold mining in Mexico is associated with the worst forms of human rights abuses, including child labor, sexual exploitation, trafficking and systematic and violent extortion of mining communities by cartels. Gold mining in Mexico has also caused large-scale cyanide spills and heavy-metal contaminated tailings.

📥 Ghana

Informal gold mining in Ghana is associated with child labor, poor workplace health and safety, and mercury usage that creates dangerous health risks as well as risk of widespread water and soil contamination. There is increasing conflict due to competition between Ghanaians and illegal Chinese immigrant workers for access to mining.

ISSUE	DESCRIPTION
High rate of depletion	Gold may become unavailable from mining within 100 years, making recycling a key area for industry action. PCBs account for about 3% of total global electronic waste. About 40% of each PCB is metal – including copper, gold, nickel and tin – offering possibilities for combined recovery efforts. Examples of initiatives addressing this issue are: - Bio-leaching of gold from PCBs - Electronic Recycling for a Circular Economy (ERICE) - ReUSE Alternative PCB Technology
Conflict	Gold is linked to illicit financial flows which can be used to fund conflict in multiple countries such as Mexico where it is known to have links with drug cartels, or the DRC where it funds non-state armed groups. Concerted industry efforts are needed to address financing conflict through the extraction and trading of gold. And example of an initiative working on this issues is the Gold and Illicit Financial Flows (GIFF) project.

ISSUE	DESCRIPTION
Unregulated artisanal and small-scale (ASM) mining practices	ASM production provides incomes for millions of families worldwide, but due to lack of regulation, it can be associated with serious environmental and human rights issues. For example, illegal ASM gold production in Peru is strongly associated with child labor, sexual exploitation and trafficking. Examples of initiatives working on developing more responsible ASM practices are Fairtrade Gold, Fairmined gold, Solidaridads gold program and the Just gold project (PAC).
Toxic chemical waste	Gold is usually processed with cyanide or mercury. When used in unregulated mining environments, these chemicals are known to cause serious environmental and health hazards, high toxicity and tendency for bioaccumulation, for example in the Amazon basin. There are several initiatives working on this issue, such as: - The Minamata Convention (2013) which catalyzed partnership efforts in Africa to eradicate use of mercury in ASM - International Cyanide Management Code for the Manufacture, Transport, and Use of Cyanide in the Production of Gold - Mercury Contamination from ASGM in Central Indonesia (Indonesia).
Water and soil pollution	Gold can occur in acidic sulfide ores, leading to risk of acidic mine discharge that causes toxic heavy metals to leach into soil and water systems. Quickly-growing mining economies, such as in China, present significant risk because they often develop without adequate infrastructure in place. Examples of initiatives include the Community-Driven ASGM Remediation Planning (Pure Earth) project.
Radioactive waste	Gold is often found in the same geological deposits as Naturally Occurring Radioactive Materials (NORM). For example, in South Africa gold is found alongside uranium. If waste is not adequately stored, it presents a serious health risk when radioactive particles seep into waterways or become airborne.
High CO ₂ emissions	Gold is associated with high levels of CO ₂ emissions during the extraction phase because large amounts of rock must be crushed to extract small amounts of ore in a very energy-intensive process.
Serious impacts on biodiversity	Alluvial gold is often found in close proximity to important water systems, protected areas and conservation zones, such as the Amazon basin. Other key gold deposits coincide with arid ecosystems, where large-scale mining projects create competition for scarce water resources. An example of an initiative working on this is the Community-Driven ASGM Remediation Planning.
Serious health issues, especially respiratory illness	Gold can be extracted from ores that are known to generate hazardous airborne pollutants when not managed responsibly, which cause a variety of respiratory illnesses. For example, informal gold mining in South Africa is associated with a high incidence of silicosis.

Indium (In)

ITO Display panel

Key Information

Primary smartphone component where indium is found	Indium-tin oxide (ITO) film (display panel)
Other key industries which use this component	Renewable energy, architecture, automotive, aeronautical
Indium content in primary component	Low
Other main materials in primary component	Tin
Other main components in which indium is found	Led, IC drivers

Consumer electronics industry consumption	Very high
Criticality for smartphone functionality	Very high
End of life recycling rate	Very low
Estimated depletion rate	Very low
Association with environmental and social issues in mining	- Radioactive waste, water/soil pollution, high CO ₂ emissions

Additional information

Indium is one of the world's rarest minerals because it is does not exist as a free element in the Earth's crust - only in trace amounts in other metal ores - primarily zinc. • Indium is extracted as a byproduct during the processing of other mineral ores, primarily zinc. • Indium supply is vulnerable due to its supply being driven by different markets than those that drive the industries which create it as a byproduct. • Supply is also vulnerable to the Chinese market and regulation. • Indium can also be recovered from metal processing wastes and recycling of indium-tin oxide (ITO) used on flat screens.

Top Producer Countries

	China	South Korea	Japan	Canada	
Global mined production	49%	20%	9%	9%	
Global reserves	MD*	MD*	MD*	MD*	
Mining sector contribution to GDP	1.2%	0.0%	0.0%	0.7%	
Government stability and perceived effectiveness		•			
Peacefulness		•			
Quality of natural resource and environmental governance		•			
Transparency		•	•		
Ease of doing business	•	•	•	•	
Human development index	MD	0.901 Very High	0.903 Very High	0.920 Very High	
Data not available due to the fact that indium is not found in elemental form.					
Very Low	Moderate	High	Very High	MD Missing Data	

Selected Issues by Country

Information on the issues associated directly with indium production is limited due to indium being a byproduct of other mineral processes. Therefore, the issues identified are those associated with zinc extraction and processing, the primary ore in which indium is found.

China

Zinc mining in China is connected with the lead industry and there is evidence of soil and water contamination by heavy metals - particularly cadmium and lead - in zinc/lead mining and processing regions.

Opportunities for Change

ISSUE	DESCRIPTION
Critical for smartphone functionality	Indium performs a function in smartphones that cannot yet viably be performed by alternative materials without significant compromise to performance quality. Industry research into alternative materials and technologies is ongoing.
End-of-life recycling rate	The supply of indium is uncertain because it is a byproduct, making recycling of indium an important area for industry action. It is estimated that less than 1% of indium is currently recycled from post-consumer waste. Example of an initiative addressing this issue: - Recycling Indium from Scraped Glass of Liquid Crystal Display: Process Optimizing and Mechanism Exploring
Radioactive waste	As a byproduct of zinc processing, indium can be associated with acidic mine discharges that cause toxic heavy metals to leach into local ecosystems if not adequately managed and stored. Fast-growing mine economies such as China present significant risk because they often develop without adequate infrastructure in place. The responsible management of radioactive waste can be addressed by specific (best- practice) standards or individual companies, but could require more attention by industry.
Water and soil pollution	As a byproduct of zinc processing, indium can be associated with acidic mine discharges that cause toxic heavy metals to leach into local ecoystems if not adequately managed and stored. Fast growing mine economies such as China present significant risk because they often develop fast without an adequate infrastructure in place. While water and soil pollution can be addressed by specific standards or individual companies, additional monitoring and attention may be required to address the long-lasting effects on communities.
High CO ₂ emissions	Indium is associated with high levels of CO ₂ emissions because it is a byproduct of energy-intensive zinc and lead processing. While specific standards address company contributions to greenhouse gases, further attention may be given to monitoring emissions reductions and more energy-efficient technologies.

I

Nickel (Ni)

Key Information

Primary smartphone component in which nickel is found	Shields
Other key industries which use this component	Automotive, aeronautics
Nickel content in primary component	Moderate
Other main materials in primary component	Manganese, silicon
Other main components in which nickel is found	Capacitors, resistors, printed circuit board, many other components

Consumer electronics industry consumption	Very high
Criticality for smartphone functionality	High
End of life recycling rate	Very high
Estimated depletion rate	Moderate
Association with environmental and social issues in mining	Serious health problems, water and soil pollution, significant biodiversity threats, moderate CO_{2} emissions

Additional information

Nickel can be connected with the cobalt industry since cobalt can be recovered as a byproduct from nickel mining and processing. • In early 2017, the Philippine government closed over 50% of the country's mines and cancelled a third of the new contracts for undeveloped sites on environmental grounds, primarily to protect watersheds.

Top Producer Countries

	Phillippines	Russia	Canada	Australia	Indonesia	New Caledonia (FR)
Global mined production	21%	9.5%	9.5%	9%	6.5%	7.5%
Global reserves	4%	10%	4%	24%	6%	10%
Mining sector contribution to GDP	2.3%	0.9%	0.7%	5.8%	0.8%	MD
Government stability and perceived effectiveness						MD
Peacefulness					•	MD
Quality of natural resource and environmental governance						MD
Transparency	•				•	MD
Ease of doing business			•			MD
Human development index	0.682 Moderate	0.804 Very High	0.920 Very High	0.939 Very High	0.689 Moderate	NA (France)
Very Low	Mod	derate	High	Very	High	MD Missing Data

Selected Issues by Country

Russia

The nickel industry in Russia is linked to extreme sulfur dioxide pollution of air and vegetation, acid rain and heavy-metal contaminated water. Norilsk is now considered one of most polluted places on earth due to nickel mining and smelting. Russian nickel plants are also connected with mercury contamination in the Arctic. All of the above have contributed to serious public health risks.

New Caledonia

New Caledonia is a territory sui generis of France with an upcoming referendum on independence. Nickel mining here is associated with water pollution, deforestation, biodiversity loss and the pollution and destruction of coral reefs.

🗮 Western Australia

Nickel mining can be associated with environmental degradation.

Indonesia

Nickel mining is linked to the exploitation and pollution of the Raja Ampat Islands marine ecosystem and conservation zone.

* Canada

T.

Nickel mining is associated with historical environmental degradation, however progressive rehabilitation is now one of the key elements of Canadian policy for post-mine planning strategies.

Philippines

A nationwide mine audit in September 2016 has led to the closure of 23 mines in 2017 – mostly nickel producers – and a possible ore export ban due to environmental compliance concerns. The Philippines is reportedly one of the most dangerous places in the world for anti-mining activists, and especially indigenous activists. Where mine interests overlap with indigenous territories or rural community land uses they can create disputes over land use claims, especially where there has been violation of the Free Prior and Informed Consent process, as in the case of the Philippines.

ISSUE	DESCRIPTION
Depletion rate	Nickel is estimated to become unavailable from mining within 100 to 1000 years, making recycling of nickel from consumer waste and improved efficiency of use increasingly important. Examples of initiatives addressing this issue are: - Bio-leaching of nickel from PCBs - Electronic Recycling for a Circular Economy (ERICE) - ReUSE Alternative PCB Technology
Serious health issues, especially respiratory illness	Nickel can be extracted from ores that are known to generate hazardous airborne pollutants when not managed responsibly, which cause a variety of respiratory illnesses when inhaled. While the issues can be addressed by individual companies or (best-practice) standards, the impact the impact on mine-workers and surrounding communities could benefit from better monitoring and specific industry action.
Water and soil pollution	Nickel can occur in acidic sulfide ores, leading to risk of acidic mine discharge that causes toxic heavy metals to leach into local water and soil systems, as in the case of Norilsk, Russia. While water and soil pollution can be addressed by specific (best-practice) standards or individual companies, it could require specific monitoring mechanisms and attention to address the long-lasting effects on communities.
Serious impacts on biodiversity	Large-scale industrial nickel mining can leave a large footprint on the surrounding environment and ecosystems. In New Caledonia and Indonesia, nickel mining has had devastating effects on protected marine areas and coral reefs. While waste management can be addressed by specific (best-practice) standards or individual companies, it may require further attention and monitoring in fragile ecosystems.
High CO ₂ emissions	Nickel is associated with high levels of CO_2 emissions due to its energy- intensive production and refining processes, demanding greater attention be given to energy-reduction technologies that will mitigate the industry's contribution to climate change.
Disputed claims over land use with indigenous communities	Where mine interests overlap with indigenous territories or rural communities they can give rise to disputes over land use claims, as in the case of the Philippines. Further attention may be given to improve community consultation and Free Prior and Informed Consent (FPIC) procedures.

Rare Earth Elements (REEs)

(Dysprosium, Neodymium, Praseodymium, Yttrium)

Key Information

Primary smartphone component where REEs are found	Speaker (NIB permanent magnets)
Other key industries which use this component	Green technology (electric vehicles and wind turbines), LED lighting
REEs content in primary component	Low
Other main materials in primary component	Iron, zinc, copper
Other main components in which REEs are found	Camera, vibration motor

Consumer electronics industry consumption	High
Criticality for smartphone functionality	Very high
End of life recycling rate	Very low
Estimated depletion rate	Low
Association with environmental and social issues in mining	Artisanal and small-scale mining, serious health issues, radioactive waste, water and soil pollution, $\rm CO_2$ emissions

Additional information

Permanent magnets are predicted to be the largest market for these four REEs until 2026. • An estimated 50% of global REE demand in the next 10 years will be driven by government-led activities, for example in the field of green technology. • A closed REE mine in Burundi considered to have one of the world's highest grade magnet REE deposits is set to reopen in 2017. • After China, the largest proportion of global reserves is in Brazil (17%) which is currently not producing.

Top Producer Countries

	China	Australia	USA	Russia	Thailand	Malaysia
Global mined production	85%	8%	3%	2%	1.5%	< 1%
Global reserves	44%	2.5%	1%	MD	MD	< 1%
Mining sector contribution to GDP	1.2%	5.8%	0.1%	0.9%	0.1%	0.3%
Government stability and perceived effectiveness						•
Peacefulness			•			•
Quality of natural resource and environmental governance		•			•	•
Transparency		•	•	•		
Ease of doing business						•
Human development index	MD	0.939 Very High	0.920 Very High	0.804 Very High	0.740 High	0.789 High

Low

Very Low





Selected Issues by Country

Russia

Russia has recently invested heavily in REE mining and is now piloting uranium-leaching technology, which may increase radiation exposure risk if not managed responsibly.

Malaysia

Malaysia is home to world's largest REE refinery outside of China, which was constructed without adequate community consultation, leading to local protests and campaigns to close the facility. The refinery has been criticized for its poor radioactive waste facilities.

China

Serious environmental violations in the REE mining industry over the last 20 years have left toxic lake legacies (Baotou, Inner Mongolia), but regulation is now becoming more stringent. Mining has also contributed to the contamination of farmland and air pollution, leading to severe public health risks – especially respiratory illness, skin diseases and cancer. Informal mining has contributed to these negative effects, prompting a crackdown on unregulated activity in 2013.

🗮 Australia

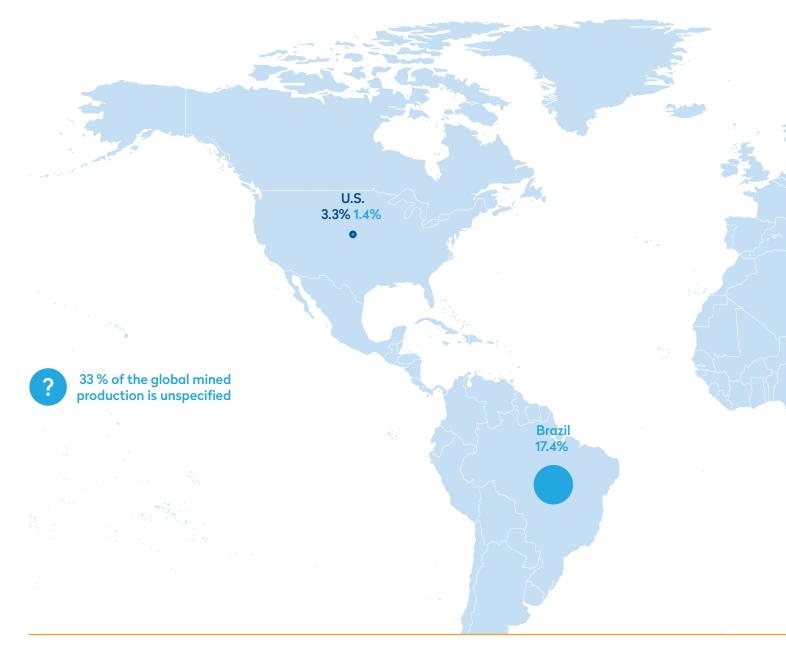
REE mining is in a growth period, with Australian companies sitting on the largest REE deposits outside of China.



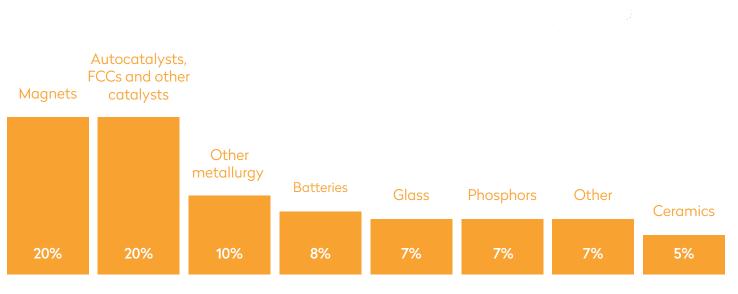
Historic mismanagement of a pipeline waste system from Mountain Pass Mine in California allowed radioactive wastewater to pollute the local desert.

ISSUE	DESCRIPTION
Critical for smartphone functionality	REEs perform functions in smartphones that cannot yet viably be performed by any other materials without significantly compromising performance quality. The Rare Earth Alternatives in Critical Technologies (REACT) is an example of an initiative seeking to address this issue.
End-of-life recycling rate	With the majority of REE production taking place in China, supply is vulnerable, yet less than 1% of REEs are currently recycled from post-consumer waste, requiring further attention.
Unregulated artisanal and small-scale (ASM) mining practices	ASM production creates livelihoods for millions of families worldwide. However, much of ASM is informal and unregulated, meaning that it can also be associated with serious environmental and human rights issues, such as in China. Improvements to the ASM sector should be pursued.
Serious health issues, especially respiratory illness	REEs are sometimes extracted from ores that are known to generate hazardous airborne pollutants when not managed responsibly, which cause a variety of respiratory illnesses when inhaled, as in the case of Bautou, China. Individual companies, the impact on mine-workers and surrounding communities could benefit from better monitoring and specific industry action.
Radioactive waste	REEs can often be found in the same geological deposits as Naturally Occurring Radioactive Materials (NORM). Where mine waste is not adequately stored, or stored in close proximity to communities, it presents a serious health risk, as in the case of Bautou, China. The responsible management of radioactive waste can be addressed by specific (best- practice) standards or individual companies, but could require more attention by industry.
Water and soil pollution	REEs can occur in acidic sulfide ores, leading to risk of acid mine drainage and leaching of toxic heavy metals into local ecosystems if not managed properly. Fast-growing mining economies such as China present significant risk because they may develop without adequate infrastructure to manage mine waste responsibly. While water and soil pollution can be addressed by specific (best-practice) standards or individual companies, it could require specific monitoring mechanisms and attention to address the long-lasting effects on communities.
CO ₂ emissions	REEs are associated with high levels of CO ₂ emissions during the extraction phase because large amounts of rock must be crushed to extract small amounts of rare earths in a very energy-intensive process. While specific standards address company contributions to greenhouse gases, further attention may be given to monitoring emissions reductions and more energy-efficient technologies.

Where Rare Earth Elements are Mined



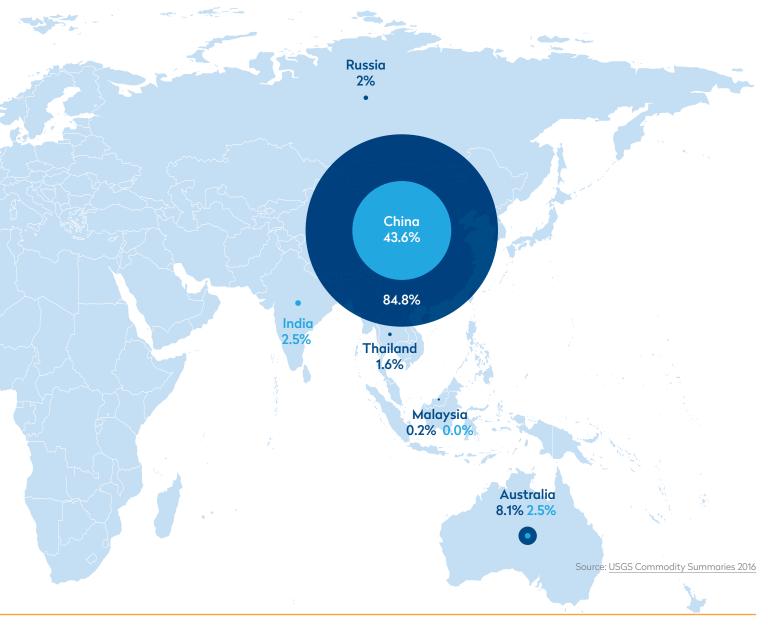
Market Consumption by Sector



24 – Rare Earth Elements

Source: Roskill Information Services / Dudley Kingsnorth, IMCOA (March 2013)





Glossary of terms

Magnets

Electric motors and generators, miniaturized IT applications, wind turbines (neodymium, praseodymium, dysprosium), green technology

Catalysts Among others, chemical processing and auto catalysts

Polishing Polishing powders for TVs batteries, e.g. for hybrid cars (several kilograms of REEs in each car)

Other metallurgy Often used to improve the mechanical characteristics of alloyed steel

Battery alloys

Nickel metal hydride batteries (NiMH), e.g. in hybrid vehicles

Glass Colouring, UV resistant glass

Phosphors Plasma displays, LCDs, energy- efficient lamps (green technology)

Ceramics: Sensors, capacitors

Tantalum (Ta)

Tantalum Capacitors

Key Information

Primary smartphone component where tantalum is found	Tantalum capacitors
Other key industries which use this component	Medical electronics
Tantalum content in primary component	High
Other main materials in primary component	Copper, silver
Other main components in which tantalum is found	Trace amounts in other components

Consumer electronics industry consumption	High
Criticality for smartphone functionality	High
End of life recycling rate	Very low
Estimated depletion rate	Low
Association with environmental and social issues in mining	Conflict, artisanal and small-scale mining, radioactive waste

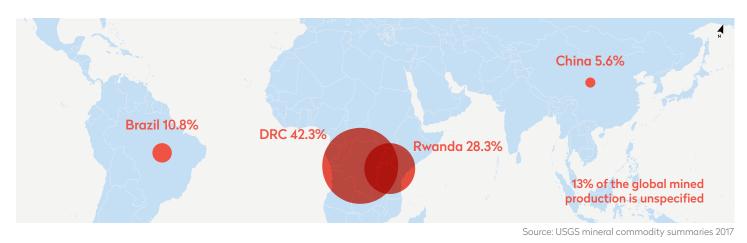
Additional information

Tantalum is primarily mined from the ore colombite-tantalite (coltan). • The use of tantalum capacitors in smartphone manufacturing is one of the primary drivers of tantalum production. • The biggest reserves yet untapped are estimated to be in Saudi Arabia. • Potential future supplies have also been identified in lower-risk countries such as Greenland, Canada, Australia and Finland.

Top Producer Countries

	Rwanda	DRC	Brazil
Global mined production * For tantalum, the updated production statistics of USGS mineral yearbook 2017 were used.	28%	42%	11%
Global reserves	MD	MD	36
Mining sector contribution to GDP	0.3%	20.3%	1.7%
Government stability and perceived effectiveness	•		•
Peacefulness	•		•
Quality of natural resource and environmental governance	•		•
Transparency	•		•
Ease of doing business	•		
Human development index	0.498 Low	0.435 Low	0.754 High
Very Low	Moderate	High Very	High MD Missing Data

Where Tantalum is Mined



Selected Issues by Country

🖊 drc

Tantalum's status as a conflict mineral is due to its association with military actors in the DRC, including the direct and indirect support of non-state armed groups. It is also mined using ASM, and associated with high levels of child labor, forced labor, small-scale bribery and corruption.

The relationship between tantalum production and the loss of habitat of the Grauer's gorilla, as well as poaching of gorillas for bushmeat to feed miners, has been well documented over the last decade. Grauer's gorilla was reclassified as "critically endangered" in 2016.

Opportunities for Change

Tantalum mining in Rwanda is associated with significant ASM production and has been associated with child labor, fraudulence in mineral provenance (much of the tantalum is suspected to originate from the DRC), internal and crossborder smuggling and low compliance in payment of taxes, fees and royalties.

📀 Brazil

Tantalum production in the Brazilian Amazon region is associated with deforestation and wetland degradation, as well as links with FARC which has been reportedly involved in the illicit trade of coltan and other minerals across the borders between Columbia, Venezuela and Brazil.

ISSUE	DESCRIPTION
Low end-of-life recycling rate	With the majority of tantalum production coming from relatively politically unstable countries, the supply is vulnerable, yet less than 1% of tantalum is currently recycled from post-consumer waste, requiring further attention.
Conflict	Tantalum is a designated "conflict mineral" due to its association with the funding of non-state armed groups in the DRC. It forms part of the 3TG together with gold, tin and tungsten. As many efforts of the industry have been directed at this issue, there are a broad range of initiatives dedicated specifically to conflict minerals, such as the Better Sourcing Program and Scaling Up Mineral Traceability (implemented by Pact and iTSCi).
Unregulated artisanal and small-scale (ASM) mining practices	The production of tantalum by ASM mining is particularly high. While ASM production creates livelihoods for millions of families, it can be associated with serious environmental and social issues. Unregulated ASM tantalum production in the DRC is strongly associated with human rights abuses such as child labor and forced labor. Supporting Sustainable Artisanal Mining in Rwanda (SSAMIR) and Solutions for Hope are examples of initiatives working to address these issues.
Radioactive waste	Tantalum can often be found in the same geological deposits as small amounts of Naturally Occurring Radioactive Materials (NORM), such as uranium and thorium. Where mine waste from LSM processing techniques is not adequately stored or managed it can present a risk of radioactive contamination (when radioactive particles seep into waterways or become airborne). The responsible management of radioactive waste can be addressed by specific (best-practice) standards or individual companies, but could require more attention by industry.

Tin (Sn)

Key Information

Primary smartphone component where tin is found	Solder
Other key industries which use this component	All electronics
Tin content in primary component	Very high
Other main materials in primary component	Copper, silver
Other main components in which tin is found	Camera, many other components

Consumer electronics industry consumption	High
Criticality for smartphone functionality	Low
End of life recycling rate	Very high
Estimated depletion rate	Moderate
Association with environmental and social issues in mining	Artisanal and small-scale mining, conflict, serious health problems, radioactive waste , water/soil pollution, significant biodiversity threats

Additional information

Tin is mined chiefly from the mineral ore cassiterite. • Tin is considered a conflict mineral due to the small amount of global production (<5%) that originates from Central Africa. However production from the DRC is set to grow significantly in 2018 when a new mine in the former conflict area goes into operation. • Test drilling is set to begin in early 2017 at a new site in Cornwall, UK, which sits on high grade reserves of tin and tungsten.

Top Producer Countries

	China	Indonesia	Myanmar	Peru	Bolivia
Global mined production	34%	17%	10%	8%	7%
Global reserves	31%	17%	MD	3%	8%
Mining sector contribution to GDP	1.2%	0.8%	0.6%	6.2%	4.7%
Government stability and perceived effectiveness	•				
Peacefulness	•	•	•	•	•
Quality of natural resource and environmental governance	•			•	
Transparency	•	-		•	
Ease of doing business	•	•		•	
Human development index	MD	0.689 Moderate	0.556 Moderate	0.740 High	0.674 Moderate

Very Low





Selected Issues by Country

China

Unregulated ASM tin production is associated with high incidence of respiratory disease, especially silicosis.

🔀 Myanmar

2016 saw rapid growth of tin mining in the autonomous Wa Province, controlled by an insurgent army, which became a key source for global electronics manufacturers and accounted for the largest share of Myanmar's tin production. Two mines were closed in 2016 for failing to uphold environmental regulation after villagers filed a lawsuit for water and soil pollution, degradation of farmland, reduced biodiversity and risks to public health.

Peru

Tin mining creates competition for, and pollution of, water supplies, as well as large-scale environmental degradation and soil erosion. Tin mining has also triggered significant corporate community conflict.

📕 Bolivia

Informal ASM is linked the use of child labor, as well as poor workplace health and safety and high incidence of respiratory disease, especially silicosis.

Indonesia

Bangka and Belitung islands produce 90% of the tin in Indonesia, where widespread environmental degradation, including marine habitats and seabed mining has been documented. Informal ASM can be associated with poor workplace health and safety, high incidence of respiratory disease and increased incidence of mosquito-borne diseases. There are laws in place that require mining concessions to be rehabilitated, but so far little action has been taken to do so.

ISSUE	DESCRIPTION
Depletion rates	Tin is estimated to become unavailable from mining within the next 100 to 1000 years, making recycling tin from consumer waste increasingly important. Examples of initiatives addressing this issue are: -Bio-leaching of tin from PCBs -Electronic Recycling for a Circular Economy (ERICE) -ReUSE Alternative PCB Technology
Conflict	Tin is a designated "conflict mineral" due to its association with the funding of non-state armed groups the DRC. It forms part of the 3TG together with gold, tantalum and tungsten and there is a broad range of initiatives dedicated specifically to conflict minerals, such as the Better Sourcing Program and the iTSCi Tin Supply Chain Initiative.
Unregulated artisanal and small-scale (ASM) mining practices	ASM production creates livelihoods for millions of families worldwide. However, unregulated ASM can also be associated with serious social and environmental issues. For example, informal ASM tin production in Bolivia is linked to the use of child labor. Improvements to the ASM sector should be pursued. An example of an initiative working on artisanal mining in Indonesia is the Indonesian Tin Working Group.
Radioactive waste	Tin can often be found in the same geological deposits as Naturally Occurring Radioactive Materials (NORM). Where mine waste is not adequately stored or where workers do not wear protective equipment, they risk exposure to dangerous levels of radiation, as in Indonesia. The responsible management of radioactive waste can be addressed by specific (best-practice) standards or individual companies, but could require more attention by industry.
Serious impacts on biodiversity	Large-scale industrial tin mining projects leave large footprints on local landscapes and ecosystems, particularly when not managed or rehabilitated responsibly, as in the case of Indonesia's islands or in Myanmar or Peru. Widespread unregulated ASM can have an equally negative impact and requires more attention.
Serious health issues, especially respiratory illness	Tin can be extracted from ores that are known to generate hazardous airborne pollutants when not managed responsibly, which cause a variety of respiratory illnesses when inhaled. Informal miners working without adequate ventilation or protective equipment are at high risk of lung disease caused by inhaling these pollutants, as in Bolivia and Indonesia where silicosis is prevalent. Individual companies, the impact on mine- workers and surrounding communities could benefit from better monitoring and specific industry action.

Tungsten (W)

Vibration Motor

Key Information

Primary smartphone component where tungsten is found	Vibration motor
Other key industries which use this component	Toy industry
Tungsten content in primary component	High
Other main materials in primary component	Iron, copper
Other main components in which tungsten is found	Filters, microphone

Consumer electronics industry consumption	Moderate
Criticality for smartphone functionality	High
End of life recycling rate	Moderate
Estimated depletion rate	Moderate
Association with environmental and social issues in mining	Artisanal and small-scale mining, conflict, serious health problems, radioactive waste

Additional information

Tungsten is predominantly mined from the mineral ore wolframite, which is considered to be a conflict mineral due to the small amount of global production that originates from Central Africa. • Tungsten production is currently in decline due to reduced Chinese and Canadian output. • Test drilling is set to begin in early 2017 at a site in Cornwall, UK, which is estimated to sit on the 4th largest tungsten deposit in the world. • Once considered relatively inert, tungsten has since been classified an as an "emerging contaminant" of concern by the US Environmental Protection Agency. Further research is required into its potential adverse effects on the environment and human health.

Top Producer Countries

	China	Vietnam	Russia	Canada	Rwanda	Bolivia
Global mined production	82%	6%	3%	2%	1%	1%
Global reserves	58%	3%	8%	9%	MD	MD
Mining sector contribution to GDP	1.2%	0.3%	0.9%	0.7%	0.3%	4.7%
Government stability and perceived effectiveness						
Peacefulness		•			•	
Quality of natural resource and environmental governance		•				
Transparency			•			
Ease of doing business				•	•	
Human development index	MD	0.683 Moderate	0.804 Very High	0.920 Very High	0.498 Low	0.674 Moderate

Very Low





Selected Issues by Country

China

"Intact forest landscapes" in Yunnan province, which are also designated UNESCO world natural heritage sites, are being lost due to the expansion of tungsten and molybdenum ore extraction activities.

★ Vietnam

Niu Phao mine, the biggest tungsten mine outside of China, is currently being investigated for its negative environmental impact, which may require local communities to relocate.

Russia

Abandoned Soviet-era tungsten mines that operated without environmental regulation, appropriate waste management or reclamation strategies have left a legacy of degraded land, loss of habitats and disruption to rural and indigenous communities.



In 2016 the dormant Cantong mine in Yukon was discovered to have unreported spillages that contaminated local waterways and soil.

Rwanda

Tungsten from Rwanda is considered a conflict mineral according to the Dodd Frank Act. It is also associated with a significant proportion of informal ASM production, poor workplace health and safety and a high incidence of respiratory disease.

ISSUE	DESCRIPTION
Moderate depletion rate	Tungsten is estimated to become unavailable from mining within the next 100 to 1000 years, making recycling of tungsten from consumer waste and improved efficiency of use increasingly important.
End-of-life recycling rate	With the majority of the tungsten production being in China, supply is vulnerable. Current recycling rates of tungsten are moderate and could be further improved.
Unregulated artisanal and small-scale (ASM) mining practices	ASM production creates livelihoods for millions of families worldwide. However, unregulated ASM can also be associated with serious social and environmental issues, such as in Rwanda where workplace health and safety can be poor. Apart from specific companies furthering ASM improvements, Supporting Sustainable Artisanal Mining in Rwanda (SSAMIR) is an example of an initiative working to address these issues.
Conflict	Tungsten is a designated "conflict mineral" due to its association with the funding of non-state armed groups in the DRC. It forms part of the 3TG together with gold, tin and tantalum, and there is a broad range of initiatives dedicated specifically to conflict minerals, such as the Better Sourcing Program.
Serious health issues, especially respiratory illness	Tungsten is extracted from ores that are known to generate hazardous airborne pollutants that threaten worker and community health when not managed responsibly. Informal miners working without adequate ventilation or protective equipment are at high risk of lung disease caused by inhaling these pollutants. Individual companies, the impact on mine- workers and surrounding communities could benefit from better monitoring and specific industry action.
Radioactive waste	Tungsten can often be found in the same geological deposits as Naturally Occurring Radioactive Materials (NORM). Where mine waste is not adequately stored, or stored in close proximity to communities, this can present a serious health risk to local ecosystems. The responsible management of radioactive waste can be addressed by specific (best- practice) standards or individual companies, but could require more attention by industry.

Initiative List

The following list provides additional examples of existing initiatives that are working to address the issues highlighted in the material profiles. Some focus on specific materials, while others relate to mineral supply chains in general. The information listed here includes a short summary of each initiative. Please visit the relevant initiative's website for more information.

The list is divided into three sections: initiatives that are relevant to all minerals, initiatives that focus on conflict minerals and initiatives that are specific to the materials profiled in this study. Within each of these sections, the initiatives are categorized according to four types: supply chain, material stewardship, upstream development and industry/trade association.

Definitions

Industry Initiative

A project in which several businesses and their stakeholders have formed a group to address a specific social or environmental issue associated with their activities or the activities of other businesses or actors in their supply chain.

Supply Chain Initiative

A project in which several businesses and their stakeholders have formed a group to address an issue where the solution is best found in collaboration with business partners in a supply chain.

Material Stewardship

A project that directly addresses a particular material and how it can be more responsibly managed throughout its physical supply chain and life cycle.

Upstream Development

A project that engages with an issue at the producer (mine) level to improve the social or environmental context in which the material is produced.

All Minerals

INITIATIVE

SCOPE (Mineral, geographical and supply chain focus)

- Downstream Companies

Supply Chain

Branded Trust Assurance System

China Chamber of Commerce of Metals, Minerals and Chemicals Importers and Exporters (CCCMC)

EICC Code of Conduct and Validated Audit Process

OECD Due Diligence Guidance for Responsible Sourcing of Minerals from Conflict Areas

Responsible Mining Index

Responsible Raw Materials Initiative (RRMI)

Materials Stewardship Initiatives

A Framework for Mining and Metals in a Sustainable World 2050 (World Economic Forum)

EICC Circular Electronics

- All minerals - Global

- All minerals

- Global

- Chinese companies, upstream
- All minerals in electronics supply chain
- Global - Downstream companies
- All minerals
- Global
- All supply chain actors

- All minerals
- Global - Upstream companies
- All minerals
- Global
 - Downstream companies

- All minerals

- Global
- All supply chain actors

- All minerals in electronics supply chains - Global

- Downstream companies

An independent social enterprise that develops technological solutions to enable the embedding of CSR tools in businesses and supply chains. BT has collated international hard and soft law, best practices in human rights, transparency, environmental responsibility and management and can incorporate bespoke industry standards. As it is not a standard-setting initiative or a traditional compliance-focused initiative it may be described as an industry training tool or standards implementation support tool. This system is still emergent; beta testing has begun with around a dozen companies across the jewelry sector.

DESCRIPTION

The CCCMC offers a set of guidelines that provide a roadmap for the responsible business conduct of Chinese companies operating overseas and for co-operation within China's mining industry. These guidelines were developed in cooperation with GIZ and with input from the OECD and Global Witness.

EICC's Code of Conduct covers environmental, social and ethical issues within all electronics supply chains.

The OECD provides guidelines for companies who source minerals to avoid involvement in supply chains that might further conflict and damage human rights. The Gold Supplement is among the supplements developed by OECD for specific minerals designed to address the particular challenges in conducting due diligence to mitigate risks during gold sourcing, processing and end use. OECD includes a recommendation for supplier capacity building measures, which goes beyond risk awareness. The recommendations are not legally binding, but are described as reflecting "the common position and political commitment of adhering countries". The Gold Supplement takes special account of ASM gold production and makes a clear distinction between expectations of small scale enterprises and informal gold mining by individuals, communities or groups. OECD focuses on due diligence, accountability and transparency issues.

The Responsible Mining Foundation's Index encourages more responsible mining by measuring performance on economic impact and environmental, social and governance issues.

RRMI will operate as a working group, co-sponsored by the Electronic Industry Citizenship Coalition (EICC) and the Conflict-Free Sourcing Initiative (CFSI), to identify and prioritize the salient social and environmental impacts of extraction and processing of raw materials in international supply chains. Working with participating companies and cross-sector partners, the RRMI will seek to advance select initiatives to drive meaningful improvement in the mining sector. In addition to focusing on 3TG, the RRMI also look at selected issues around cobalt in the DRC and adopting a convening role for the Tin Working Group.

Throughout this ongoing process, RRMI will promote member and stakeholder engagement, education and participation through an active advocacy focus on these issues.

Under the mandate of the World Economic Forum's Mining and Metals Industry Governors Community, this framework was developed to guide the mining and metals sector in transitioning to a more sustainable world by 2050. Looking forward to 2050, four fundamental principles of sustainability were asserted, framing the desired end state and the way the industry should operate in a sustainable world. The four principles are grouped under: environment and climate conservation, fair value and development (responsible mineral development), transparency and human rights, and health and well-being.

Pending initiative. A report commissioned by Antea in 2016 recommends that the EICC should drive progress with circular electronics, for example by designing for recovery and reuse, increasing urban mining, recycling similar WEEE together and conducting R&D in REE recycling.

Initiative List – 33

All Minerals

	SCOPE (Mineral, geographical and supply chain focus)	DESCRIPTION
The Circular Economy 100 (Ellen McArthur Foundation)	- All minerals - Global - Downstream companies	The Circular Economy 100 is an innovation program established to enable orga nizations to develop new opportunities and realize their circular economy ambitions faster. It brings together corporations, governments and cities, academic institutions, emerging innovators and affiliates in a unique multi-stakeholder platform. The platform organizes CE100 acceleration workshops to foster collaboration between companies and sectors, as well as collaborative projects (Co.Projects) focusing on developing research or pilots to overcome challenges and explore opportunities to transition to a circular economy.
Upstream Development Initiatives		
ICMM Sustainable Development Framework	- All minerals. - Global. - Upstream companies	The International Council for Mining and Metals developed a Sustainable Development Framework as part of its stated commitment to improve sustainable development performance across the industry. The Framework is a set of guidelines comprising ten principles that cover business practices, corporate decision-making, human rights and cultural respect, risk management strategies, health and safety, conservation, responsible product design and disposal, community development and communications. All ICMM member companies must demonstrate they are meeting the requirements of ICMM membership in an annual public report as described in ICMM's Assurance Procedure.
IRMA (Initiative for Responsible Mining Assurance)	 All minerals (except energy) Global Specific focus on large-scale industrial mining 	A cross-sector initiative by Earthworks that includes jewelry brands, mining companies and NGOs to create a standard for responsible mining. The standard covers social responsibility, business integrity, environmental responsibility, management and mine closure and reclamation. Certification covers specific mine sites but allows purchaser traceability and provides a full set of claims.
KIN Catalyst for Mining's Development Partner Framework	- All minerals - Global - Upstream companies	The Framework details best practices for collaboration between the industry and stakeholders and is anchored by three pillars: shared purpose, thriving ecosystems, and competitive companies, communities and countries. It was developed by a working group of mining companies, investors, suppliers, NGOs, indigenous groups, researchers and government.
FPIC Solutions Dialogue	- All minerals - Global - Upstream companies	The FPIC Solutions Dialogue is a multi-sector initiative to develop practical guidance to support free, prior, informed consent (FPIC) community processes relating to mining, oil and gas projects. RESOLVE is the convener and program secretariat. Program participants are working in partnership to identify FPIC guidance derived from site-based experiences. However, participation in the program does not suggest any formal or legal partnership, nor does participation in the development or evaluation of case studies suggest endorsement.
Devonshire Initiative	- All minerals - Global - Canadian mining companies and community development NGOs	The Devonshire Initiative (DI) is a collaborative problem-solving forum with the objective of improving social and community development outcomes in communities where their industry and NGO members operate. The DI provides four specific areas of value addition to its members and stakeholders: 1) opening dialogue that creates a better understanding of, and that deepens engagement on, social and community development components of CSR work being done by Canadian mining companies operating in developing countries; 2) enhancing cross-sector Canadian engagement with, and understanding of community development issues; 3) sharing innovations and best practices within the mining and development community; and 4) enhancing in-country capacity to allow communities, regions and countries to more visibly realize the benefits of Canadian mining investments.
The Extractive Industries Transparency Initiative (EITI)	- All minerals. - Global. - Upstream companies	The Extractive Industries Transparency Initiative (EITI) is a global standard to promote the open and accountable management of oil, gas and mineral resources. The Standard seeks to address the key governance issues of the oil, gas and mining sectors. The EITI Standard requires information along the extractive industry value chain from the point of extraction and how the

the extractive industry value chain from the point of extraction and how the revenue makes its way through the government, to how it benefits the public.

Conflict Minerals

INITIATIVE	SCOPE (Mineral, geographical and supply chain focus)	DESCRIPTION
Supply Chain Initiatives		
Better Sourcing Program (BSP)	 Conflict minerals (expanding to other minerals) Conflict and high risk countries Upstream companies 	The Better Sourcing Program provides due diligence services to local mining operators and communities, to improve the terms of their access to compliant international markets and investment. The program combines local expertise with technology to deliver a continuous flow of data and insight into artisanal and small scale mining (ASM) globally. It deploys innovative tools to monitor mining operations for risks and impact on the community, trace the flow of materials in real time, and empower local mining cooperatives and companies to validate their exports against international standards. Over time, the Better Sourcing model conditions exports to verifiable improvement of local supply chain circumstances.
Conflict Free Sourcing Initiative and Program (CFSI and CFSP)	- Conflict minerals - Global - Downstream, smelters and refiners	CFSI is an industry initiative that was founded in 2008 by members of the Electronic Industry Citizenship Coalition and the Global e-Sustainability Initiative and offers one of the most utilized and respected resources for companies addressing responsible sourcing issues for conflict minerals.
European Partnership on Responsible Minerals (EPRM)	 Conflict minerals DRC, Ivory Coast, Colombia, Indonesia Downstream and midstream companies 	The EPRM initiative has been established to accompany the EU Conflict Minerals Regulation. Participation in the EPRM is entirely voluntary and activities fall under two categories. First, it will serve as a knowledge platform for companies to discuss due diligence activities, and will raise awareness on due diligence with EU companies, especially SMEs. Second, it will finance activities both in conflict-affected and high-risk areas to increase the supply of conflict-free minerals.
ICGLR Mineral Tracking and Certification Scheme	- Conflict minerals - Great Lakes Region - Upstream companies	The International Conference on the Great Lakes Region (ICGLR) is a certification scheme set up to function similarly to the Kimberley Process Certificates for diamond exports, meaning that only mineral shipments that can demonstrate "conflict free" origin, transport and processing will be awarded an ICGLR Certificate.
iTSCi Program	- Conflict minerals - Great Lakes Region and DRC - Upstream companies	ITRI's iTSCi program is a joint industry program of traceability and due diligence designed to address concerns over "conflict minerals" from central Africa. The iTSCi system aims to meet the needs of companies wishing to maintain trade with responsible supply chain actors in the Democratic Republic of the Congo (DRC) and adjoining countries, as well as to meet due diligence expectations of the international community in terms of guidance from the UN, OECD and national laws such as the Dodd-Frank Act in the US. iTSCi aims to encourage sustainable production and economic development in the longer term.
JEITA Responsible Minerals Rrade Working Group (JEITA)	- Conflict Minerals - Great Lakes Regions and DRC - Downstream Japanese companies	Japan Electronics and Information Technology Industries Association (JEITA) has set up the JEITA Responsible Minerals Trade Working Group to achieve responsible sourcing of minerals and to deal with Section 1502 of the Dodd-Frank Act and other relevant regulations. The main action areas of the working group are to take the lead in planning and implementation of reasonable and effective policies with consideration for JEITA members' interests and minimization of cost, and to improve Japanese companies' international presence by collaborating on initiatives such as the EICC/GeSI program.
MineralCare	- Conflict minerals and diamonds - Global	MineralCare guarantees transparency and legitimacy throughout the whole chain of custody, complying with the guidelines issued by the OECD Due Diligence Guidance for Responsible Supply Chain of Minerals from Conflict- Affected and High-Risk Areas, the provisions of the Dodd-Frank Act (US) and several other standards. The initiative is able to offer confidence in conflict- free supply chains without inhibiting trade flows and without stigmatizing the industry or any African region.
Public Private Alliance for Responsible Minerals Trade (PPA)	- Conflict minerals. - Great Lakes Region and DRC - Downstream companies	The PPA provides funding and coordination support to organizations working within the region to develop verifiable conflict-free supply chains, align due diligence programs and practices, encourage responsible sourcing from the region, promote transparency and bolster in-region civil society and governmental capacity. The PPA periodically offers funding opportunities for projects that support efforts to develop and/or deploy ICGLR and OECD- compliant, validated, certified and traceable mines and supply chain routes for gold, tin, tantalum and tungsten in the Great Lakes Region.
Solutions for Hope	- Conflict minerals - Global - Downstream companies	Solutions for Hope is a platform that connects actors at all stages of the supply chain to enable responsible sourcing of minerals from conflict- affected countries, such as the Democratic Republic of the Congo (DRC), as well as post-conflict regions.

as well as post-conflict regions.

Conflict Minerals

INITIATIVE

SCOPE (Mineral, geographical and supply chain focus)

Cobalt

Supply	Chain	Initiatives
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Responsible Cobalt Initiative - Cobalt - DRC - Downstream companies Initiative led by CCMMC in partnership with downstream companies and support from OECD and Government of DRC. RCI has three primary objectives. First, they aim to have downstream and upstream companies recognize and align their supply chain policies with the OECD Due Diligence Guidance and CCCMC's Chinese Due Diligence Guidelines for Responsible Mineral Supply Chains in order to increase transparency in the cobalt supply chain and improve supply chain governance. Second, they aim to promote cooperation with the Government of the Democratic Republic of the Congo, civil society and affected local communities to take and/or support actions that address the risks and challenges in the cobalt supply chain. Third, they aim to develop a common communication strategy to communicate progress and results effectively to impacted communities, miners, and the public to harmonize working objectives and plans with other stakeholders.

DESCRIPTION

Upstream Development Initiative

Stop Child Labour Coalition's "Out of work and into school" program

Center for Effective Global Action (CEGA)

Industry/Trade Association

Cobalt Development Institute (CDI) Cobalt
 Global
 Companies engaged in Cobalt supply chains.

- DRC

- Cobalt

- DRC

- Upstream actors

- All mineral used in electronics supply chains

An initiative that supports the elimination of child labor by strengthening an area-based approach towards child labor free zones. Where possible, the partners seek the active participation of sustainability initiatives and companies, with a particular emphasis on electronics companies cleaning up their supply chains.

UC Berkeley research partnership investigating health and safety and child labor within cobalt supply chains originating from the DRC.

The Cobalt Development Institute (CDI) is a non-profit trade association composed of producers, users, recyclers and traders of cobalt. CDI promotes the sustainable and responsible production and use of cobalt in all its forms. An initiative on cobalt is currently pending.

Copper

Materials Stewardship Initiatives

Bio-leaching of copper from PCBs (Research phase)

ReUSE Alternative PCB Technology (Research phase)

ERICE (Electronic Recycling in a Circular Economy)

Industry/Trade Association

Copper Alliance (International Copper Association

- All minerals used in electronic PCBs
- Global
 Recyclers and downstream companies
 - All minerals used in electronic PCBs.
 - Global
 Recyclers and downstream companies
 - All minerals used in electronic PCBs
- Global
 Recyclers and downstream companies
- Copper
- Global
- Companies engaged in Copper supply chain

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Bio-leaching presents a microbiological alternative to pyrometallurgical and hydrometallurgical processes for metal recycling, which are energy and cost intensive. The research and process is yet to be applied to commercial recycling of waste electronic material.

The ReUSE project designed a printed circuit board (PCB) whose components can be easily separated by immersion in hot water due to alternative substrate materials -- aiding end-of-life disassembly and allowing for easy harvesting of constituent materials and component parts. This revolutionary technology allows 90% of the original structure to be reused. In comparison, less than 2% of traditional PCB material can be reused.

ERICE was a follow up project from ReUSE (above) to demonstrate the commercial viability of the new technology by producing a fully functioning electronic device using waste material from another PCB. It was shortlisted for Innovation of the Year Award (Business Green Leaders Awards) 2016.

The members of the International Copper Association, Ltd. (ICA), together with the alliance of national and regional associations and over 500 program partners defend and grow markets for copper based on its superior technical performance and its contribution to a higher quality of life worldwide. The Alliance is engaged in advocacy, applied research, sustainable development and communication.

INITIATIVE

SCOPE (Mineral, geographical and supply chain focus)

Gallium

Industry/Trade Association

Minor Metals Trade Association (MMTA)

- Minor metals, including indium
- and gallium - Global

- Gold

- Gold

- Global

- Conflict countries

- Upstream companies

- Upstream and downstream

companies in the UAE

- Gold produced via ASM

- Companies engaged in minor metal supply chains

MMTA is a not-for-profit organization, serving to benefit and promote the interests of its international membership, comprising companies actively involved in all aspects of the international minor metals sector. The MMTA informs on such issues as leaislative and reaulatory changes, as well as conveying the concerns and suggestions of the membership to those responsible for setting policy.

DESCRIPTION

Gold

Supply Chain Initiatives

Conflict Free Gold Standards

Dubai Multi Commodity Centre Practical Sourcing Guidance

Fairmined Gold

Fairtrade Gold

Gold and Illicit Financial Flows (GIFF) Project

Just Gold Project (Partnership Africa Canada)

LBMA Responsible Gold Guidance

Responsible Jewellery Council (RJC)

- Peru, Bolivia Columbia, Mongolia) - ASM mines - Gold produced via ASM. Peru, Uganda - ASM mines, supply chain actors - Gold produced via ASM - Global All companies involved with ASM gold supply chains
 - Gold produced via ASM
- DRC - ASM mines
- Gold - Global
- Smelters and refiners
- Gold
- Global
- LSM and ASM, but currently mainly applied to LSM

Developed by the World Gold Council and based on internationally recognized benchmarks, the Conflict-Free Gold Standard helps companies to provide assurance that their gold is not contributing to conflict. The Standard helps to "operationalize" the OECD's Due Diligence Guidance for Responsible Supply Chains for Minerals from Conflict-Affected and High-Risk Areas.

DMCC is a government entity established in 2002 to enhance commodity trade flows through Dubai. The DMCC performs a range of roles which continue to position Dubai as the preferred destination for global commodities trade and DMCC as the world's leading Free Zone. The DMCC has developed the Practical Guidance for Market Participants in the Gold and Precious Metals Industry that provides guidance to gold refiners on due diligence for responsible supply chains.

An assurance system certifying that ASMs comply with the Fairmined Standard to produce traceable and responsible gold. Similar to the Fairtrade standard but with a slightly different business model and subtle differences to the standards, which are marginally less stringent than Fairtrade. Fairmined has demonstrated some successful B2B partnerships.

An assurance system certifying that artisanal and small-scale gold miners comply with the Fairtrade Standard to produce traceable and responsible gold. This can help them to improve their mining and business practices as well as open the market to generate more sales on better terms. The Standards include strict requirements on working conditions, health and safety, handling chemicals, women's rights, child labor and protection of the environment.

The GIFF project's key objectives are to raise awareness and understanding of IFFs and criminal networks in gold supply chains, to create a network of stakeholders interested in and working on ASGM formalization and IFFs in gold supply chains that will share knowledge and strategies, and to provide stakeholders and decision makers with tools to identify, map and address IFFs in dialogues between stakeholders and developing a toolkit to prevent illegal activity in gold supply chains. The project is led by Estelle Levin Ltd and Global Initiative, and funded by GIZ.

The Just Gold Project aims to bring legal, conflict-free artisanal gold from the Democratic Republic of the Congo to international markets. The project calls for ICGLR Member States and the DRC government to minimize the illegal exploitation of gold by harmonizing taxation levels between countries and tackling the unchecked system of formal and informal taxation within the DRC's borders.

LBMA Responsible Gold Guidance is a risk-based due diligence framework based on OECD Guidance for Responsible Supply Chains of Minerals from Conflict-Affected and High-Risk Areas. The guidance follows a flexible five-step framework designed for refiners to avoid gold that contributes to conflict, human rights abuses, terrorist financing practices and money laundering.

Founded in 2005, the Responsible Jewellery Council is a non-profit standards and certification organization. Its 900 Member companies span the entire jewelry supply chain from mines to retail. RJC Members are independently audited against the RJC Code of Practices - an international standard on responsible business practices for diamonds, gold and platinum group metals. The Code of Practices addresses human rights, labor rights, environmental impact, mining practices, product disclosure and more.

INITIATIVE	SCOPE (Mineral, geographical and supply chain focus)	DESCRIPTION
SBGA's Better Gold Initiative	- Gold produced via ASM (and middle- scale if connected to ASM) - Peru, with projects pending in Columbia and Brazil	The Better Gold Initiative follows Fairtrade and Fairmined standards. Through targeted interventions in production, trade and demand, the initiative hopes to increase the supply of sustainably produced gold from small and medium-sized mines, reinforce relevant voluntary sustainability standards and bring together various stakeholders along the value chain. This will enable small and medium-sized mines to meet the growing requirements regarding traceability and responsible production and help secure better incomes and long-term access to international markets. The initiative is a public-private partnership between SECO and the Swiss Better Gold Association, which is starting in Peru and plans to expand to other countries.
Solidaridads Gold Program	- Gold - Peru, Colombia, Bolivia, Ghana, Uganda, Tanzania and Kenya - ASM mines and supply chain actors	Solidaridad is working to transform gold production into a driver of better, more equitable outcomes from mine to market. In cooperation with partners – from governments, the private sector, research institutes, foundations, local civil society organizations – Solidaridad works with miners to improve their livelihoods. The biggest market need is to increase the supply of good gold to meet an ever increasing demand for responsibly sourced, non-conflict minerals. Solidaridad's improvement program for small-scale mining is the largest in the world, with over 5,000 miners and an estimated 35,000 mining community members who have already benefited from Solidaridad's engagement. They
Materials Stewardship Initiatives		currently work in 26 mining communities, across eight countries.
Bio-leaching of gold from PCBs (Research phase)	- All minerals used in electronic PCBs - Global - Recyclers and downstream companies	Bio-leaching presents a microbiological alternative to pyrometallurgical and hydrometallurgical processes for metal recycling, which are energy and cost intensive. The research and process is yet to be applied to commercial recycling of waste electronic material.
ERICE (Electronic Recycling in a Circular Economy) (Research phase)	- All minerals used in electronic PCBs - Global - Recyclers and downstream companies	ERICE was a follow up project from ReUSE to demonstrate commercial viability of the new technology by producing a fully functioning electronic device using waste material from another PCB. It was shortlisted for Innovation of the Year Award (Business Green Leaders Awards) 2016.
International Cyanide Management Code for the Manufacture, Transport and Use of Cyanide in the Production of Gold (Cyanide Code)	 Gold produced by large-scale mining Global Upstream and mid-tier companies involved with industrial gold supply chains 	The Cyanide Code is a voluntary initiative for the gold mining industry and the producers and transporters of the cyanide used in gold mining. It is intended to complement an operation's existing regulatory requirements. Compliance with the rules, regulations and laws of the applicable political jurisdiction is necessary; the Cyanide Code is not intended to contravene such laws. Developed by a multi-stakeholder Steering Committee under the guidance of the United Nations Environmental Program (UNEP) and the then-International Council on Metals and the Environment (ICME).
Upstream Development Initiatives		
Community-Driven ASGM Remediation Planning	- Gold produced via ASM - Peru - ASM mines	Lead by Pure Earth, with US Department of State and Center for Research on Environmental Health, this project will help the Peruvian government to assess ASGM sites for contamination and degradation, develop community- driven remediation plans and strategies for alternative livelihoods and mercury-free ASGM practices, and conduct remediation and rehabilitation of contaminated and environmentally degraded ASGM sites.
CAPAZ - Cadenas de PAZ, Solutions for Hope	- Gold produced via ASM in Colombia	With initial support from the European Partnership for Responsible Minerals (EPRM), CAPAZ is seeking to develop and pilot an open source and globally applicable Market Entry Standard for commercial engagement with artisanal and small scale gold mining, especially in Conflict-Affected and High-Risk Areas (CAHRAs). The standard will ensure compliance with OECD due diligence guidance, providing a "passport to markets" for artisanal miners while establishing efficiency and confidence for downstream companies and refiners seeking to engage with artisanal miners.
		By establishing clear, appropriate and widely-accepted criteria and expectations – and by demonstrating their efficacy through pilots – CAPAZ expects the Market Entry Standard to reduce the cost and time required for upstream and downstream partners to navigate these questions, while increasing the speed with which high-quality due diligence can be conducted and new artisanal gold supplies can be brought online.

	SCOPE (Mineral, geographical and supply chain focus)	DESCRIPTION
Convening Stakeholders to Develop and Implement Strategies to Reduce Child Labor and Improve Working Conditions in ASGM (COSTREC-ASGM)	- Gold produced via ASM - Ghana, Philippines. ASM mines	Led by US Department of Labor and funded by the ILO, this project runs from 2015 to 2019. The project will work with a wide range of stakeholders, including national, regional and local governments, miner associations, mining companies, trade unions, NGOs/civil society groups, media, academia, communities, miners, parents and children. The project will convene stakeholders to develop and implement strategies to reduce child labor and improve working conditions in ASM gold mining communities.
Mercury Contamination from ASGM in Central Indonesia	- Gold produced via ASM - Indonesia	Lead by Pure Earth in collaboration with the World Bank, UNIDO and YTS, this project has identified major sources of mercury emissions and YTS is currently implementing a community-based, participatory project to mitigate future mercury release. The direct intervention initiative aims to lower the level of mercury consumed by gold-processors and subsequent emissions from burning mercury amalgam. Improving local technologies provides an important entry point into this community and allows the project to collaborate with the gold processors to solve their problems. Improving the miners' ability to recover mercury and promoting mercury recycling reduces both mercury emissions and the demand for further mercury.
Oro Legal	- Gold - Colombia - ASM mines	The USAID-funded Oro Legal (Spanish for "legal gold") project, implemented by Chemonics, brings the Colombian government and large mining opera- tions together to create a shared agenda for sustainable change in the gold mining sector. The program facilitates discussions and plans between these groups, supporting responsible mining where is it is technically, financially and legally feasible to do so. The program aligns itself with government policy regarding mining and focuses on the regions of Antioquia and Choco.
Stop Child Labour Coalition's "Out of work and into school" program	- Gold produced via ASM - Mali	This project supports the elimination of child labor by strengthening an area- based approach towards child labor free zones. Where possible, the partners seek the active participation of sustainability initiatives and companies, with a particular emphasis on electronics companies cleaning up their supply chains.
Industry/Trade Association		
Sustainable Artisanal Mining (SAM) Project	- Gold produced via ASM - Mongolia	The SAM Phase 4 project builds upon 10 years of implementation and aims to consolidate progress towards responsible community mining within an enabling legal framework for Mongolia's 60,000 artisanal miners and their dependents. The project seeks to transform Mongolia into an international knowledge hub for ASM best practices. The project's development goal is "an economically sustainable, environmentally responsible and human rights based ASM sector in Mongolia benefiting from, and contributing to, global best practices regarding artisanal and small-scale mining".
World Gold Council	- Gold - Global - All companies in gold supply chain	The World Gold Council (WGC) is the market development organization for the gold industry. Its purpose is to stimulate and sustain demand for gold, provide industry leadership and be the global authority on the gold market. WGC also developed the Conflict-Free Gold Standards.

Indium

Material Stewardship Initiatives

Recycling Indium from Scraped Glass of Liquid Crystal Display: Process Optimizing and Mechanism Exploring

Industry/Trade Association

Minor Metals Trade Association (MMTA) - Global - Research phase Research by Key Laboratory for Solid Waste Management and Environment Safety, School of Environment, Tsinghua University, funded by the National Natural Science Foundation of China and the China Postdoctoral Science Foundation. The research motivated by the aim is to move towards a closed-loop supply chain of indium. LCD recycling can contribute to the sustainability of the electronics industry by facilitating recovery of indium from discarded electronics rather than dwindling reserves.

MMTA is a not-for-profit industry organization, serving to benefit and promote the interests of its international membership, comprising companies actively involved in all aspects of the international minor metals sector. The MMTA informs on such issues as legislative and regulatory changes, as well as conveying the concerns and suggestions of the membership to those responsible for setting policy.

- Minor metals, including indium and gallium

 All companies involved in minor metals supply chains

	SCOPE (Mineral, geographical and supply chain focus)	DESCRIPTION
Nickel		
Material Stewardship Initiatives		
Bio-leaching of nickel from PCBs (Research phase)	- All minerals used in electronic PCBs - Global	Bio-leaching presents a microbiological alternative to pyrometallurgical and hydrometallurgical processes for metal recycling, which are energy and cost intensive. The research and process is yet to be applied to commercial recycling of waste electronic material.
ReUSE Alternative PCB Technology (Research phase)	- All minerals used in electronic PCBs - Global	The ReUSE project designed a printed circuit board (PCB) whose components can be easily separated by immersion in hot water due to alternative substrate materials aiding end-of-life disassembly and allowing for easy harvesting of constituent materials and component parts. This revolutionary technology allows 90% of the original structure to be reused. In comparison, less than 2% of traditional PCB material can be reused.
ERICE (Electronic Recycling in a Circular Economy) (Research phase)	- All minerals used in electronic PCBs - Global	ERICE was a follow up project from ReUSE (above) to demonstrate commercial viability of the new technology by producing a fully functioning electronic device using waste material from another PCB. It was shortlisted for Innovation of the Year Award (Business Green Leaders Awards) 2016.
Industry/Trade Association		
Nickel Institute	- Nickel - Global - All companies involved in Nickel supply chains	Nickel Institute is the global industry association of the world's primary nickel producers who together account for approximately 85% of the worldwide annual nickel production outside China. It is engaged in promoting and supporting the use of nickel in appropriate applications and promotes sound science, risk management and socio-economic benefits as the basis for public policy and regulation. It also has a scientific research arm, Nipera.

Rare Earth Elements

Supply Chain Initiatives		
European Rare Earths Competency Network (ERECON)	- REEs - Europe - All companies involved in Rare Earth supply chains	To address the issue of rare earth elements' supply, the European Commission has brought together experts to form a European Rare Earths Competency Network. The three Working Groups of ERECON are focused on opportunities and road blocks for the primary supply of rare earths in Europe, European rare earths resource efficiency and recycling, and European end- user industries and rare earths supply trends and challenges.
Material Stewardship Initiatives		
CMI Recovery Processes for REEs	- REEs in electronics, automotive and extractive supply chains	CMI (Critical Materials Institute) is a Department of Energy Innovation Hub led by the U.S. Department of Energy's Ames Laboratory. CMI seeks ways to eliminate and reduce reliance on rare earth metals and other materials critical to the success of clean energy technologies. It currently partners with electronics, automotive and extractive companies such as Siemens, Ford, Bosch and Molycorp.
ORNL Rare Earth Magnet Recycling Process	- REEs used in permanent magnets - Recyclers and downstream users	The US Department of Energy's Oak Ridge National Laboratory and Momentum Technologies conduct basic and applied research to deliver transformative solutions to compelling problems in energy and security. They have developed a new process as part of DOE's Critical Materials Institute that is designed to economically recover large amounts of magnets made using neodymium. It is now licensed to Momentum Technologies.
Honda Car Battery Recycling	- REEs used in automotive - Downstream companies	Honda is currently implementing research and developing processes to better capture REEs from recycled car batteries.
MORE Project (Motor Recycling)	- REEs used in automotive - Downstream companies	Led by Siemens, the MORE Project is an industry initiative looking at recycling solutions for electric motors. The main focus is on permanent magnets which have a high proportion of rare earth metals and are needed for electric and hybrid vehicles. The partners in MORE are looking at the entire value chain from designing and producing the motors right up to their reuse. The project is being funded by the German Federal Ministry of Education and Research (BMBF).

	SCOPE (Mineral, geographical and supply chain focus)	DESCRIPTION
Recovery of Rare Earth Elements from Coal Mine Drainage	- REEs - USA - Upstream coal companies	Some coal-related waste streams are enriched with REEs, sparking interest in evaluation of these wastes as a potential domestic supply. West Virginia University's project, "Recovery of Rare Earth Elements from Coal Mine Drainage," brings together academia, state regulators and the industry to collaborate on finding a successful recovery technology for total REEs from acid mine drainage, or AMD.
Industry/Trade Association		
The Association for Rare Earth	- REEs - Global - All companies involved in Rare Earth supply chains	The Association is engaged in the promotion of (affordable) rare earth mining, research, advocacy, education and training. The policy committee of the Association is planning to work with member companies to develop an international set of principles for mining and processing rare earth materials which signing companies will commit to meeting.
Tantalum		
Material Stewardship Initiatives		
Tantalum Capacitor Scrap Recycling	- Tantalum - Global - Recyclers and downstream companies	An initiative by recycling company Tantalum Recycling to recapture and recycle tantalum specifically from capacitors in WEEE.
Upstream Development Initiatives		
Supporting Sustainable Artisanal Mining in Rwanda (SSAMIR)	- All minerals produced via ASM - Rwanda - Upstream companies	DFID's SSAMIR Program is a three-year (2017-2020) effort to promote economically and environmentally sustainable growth of Rwanda's mining sector. The project will contribute to increased openness, transparency and professionalism in the mining sector, greater efficiency and economic viability in line with environmental best practices, and increased private investment and a stronger knowledge base on artisanal mining.
Industry/Trade Association		
Tantalum-Niobium International Study Centre (T.I.C.)	- Tantalum and niobium - Global - All companies involved in tantalum and niobium supply chains	The TIC is an international not-for-profit association comprising around 90 member companies involved with all aspects of the tantalum and niobium industry supply chain. The TIC's primary objectives are to promote the properties of tantalum and niobium and address major issues and challenges facing the industry such as conflict minerals' legislation, artisanal and small-scale mining and transport of radioactive materials. The T.I.C. Working Group on Tantalum and Niobium provides due diligence guidelines based on OECD guidance. Includes a specific policy on ASM.
Tin		
Supply Chain Initiatives		
IDH Indonesia Tin	- Tin	The Sustainable Trade Initiative's (IDH) Tin Working Group aims to address

IDH Indonesia Tin Working Group

Tin - Indonesia

- Global, all companies involved in tin supply chains

The Sustainable Trade Initiative's (IDH) Tin Working Group aims to addre the sustainability challenges of tin mining and smelting in Bangka and Belitung while recognizing the economic benefits of the sector. The program focuses on driving the implementation of a road map for responsible tin mining in Indonesia. In addition, the program is creating incentives that midstream and downstream tin users (Tin Working Group private members) can implement to support a lasting tin industry transformation.

Upstream Development . Initiatives

Stop Child Labour Coalition's "Out of work and into school" program - Indonesia - Upstream

Supports the elimination of child labor by strengthening an area-based approach towards child labor free zones. Where possible, the partners seek the active participation of sustainability initiatives and companies, with a particular emphasis on electronics companies cleaning up their supply chains.

INITIATIVE

SCOPE (Mineral, geographical and supply chain focus)

DESCRIPTION

Industry/Trade Association

International Tin Institute (ITRI)

- Tin - Global
- Companies involved in tin supply chains

ITRI is a not-for-profit membership based organization limited by guarantee. It represents the tin industry and is supported by the world's most important tin producers and smelters. ITRI's principal aim is to support and encourage the use of tin in existing and new applications. It has developed several initiatives geared towards sustainability of the tin sector, including iTSCI and is currently in the process of developing a code of conduct for its members, including of other parts of the supply chain such as traders or metal exchanges in the longer term.

Tungsten

Industry/Trade Association

International Tungsten Industry Association (ITIA)

Tungsten
Global
Companies involved in tungsten supply chains

An international not-for-profit association, whose principal aims include promoting of tungsten together with coordinating the scientific work program of the ITIA Health, Safety and Environment Committee which develops data on the impact of tungsten on human health and the environment.

Indicator List

This list explains the indicators that are used in the individual material profiles, namely in the Key Information, Top Producer Country and the Selected Issues per Country sections. The indicators used in the Key Information section are the same indicators that are included in the Materials Matrix from the first phase of our materials scoping research.

Some indicators are based on a single data point, while others are aggregated from multiple statistics. Please browse through the indicator list to learn more about the meaning and data sources for each of the indicators.

Key Information

Indicators mentioned in 'key information' section

Please refer to the Guide to the Scoping Study for an explanation of these indicators. The guide is available at www.fairphone.com.

Top Producer Countries

Indicator	Definition
Global Mined Production %	Percentage of total Global Mined Production estimated to come from the named country. USGS Commodity Summaries 2016.
Global Reserves %	Percentage of total global reserves estimated to be available to mine within the named country. Reserves are calculated according to what is economically available and viable to mine, not what is physically present in the Earth's crust. USGS Commodity Summaries 2016.
Mining Sector Contribution to GDP %	From the World Development Indicator "Contribution of natural resources to gross domestic product". Percentage of gross domestic product (GDP) attributable to mineral rents, where "mineral" excludes coal, oil and gas. The indicator is therefore not specific to the material mentioned in the individual profile. Note that this indicator does not exclude that, even where the mining sector does not contribute a large percentage to the GDP, for some specific regions within a country mining can still contribute to a large extent to community income, especially when artisanal mining is widely practiced.

Government Stability and Perceived Effectiveness

Indicator

Fragile States Index

Score from 0-100, where 0 = very sustainable, 100 = very high alert Very Low: 0-20 Low: 21-40 Moderate: 41-60 High: 61-80 Very High: 81-100

Voice and Accountability

Score from 0-100, where 0 = weak voice and accountability, 100 = strong voice and accountability Very Low: 0-20 Low: 21-40 Moderate: 41-60 High: 61-80 Very High: 81-100

Political Stability

Score from 0-100, where 0 = politically unstable, 100 = politically stable Very Low: 0-20 Low: 21-40 Moderate: 41-60 High: 61-80 Very High: 81-100

Government Effectiveness

Score from 0-100, where 0 = ineffective aovernment. 100 = effective government Very Low: 0-20 Low: 21-40 Moderate: 41-60 High: 61-80 Very High: 81-100

Definition

An annual report published by the Fund for Peace and the magazine Foreign Policy since 2005. The list assesses 178 states' vulnerability to conflict or collapse, ranking all UN member sovereign states according to 12 social, economic and political indicators. For the purpose of this study scores have been converted to a scale of 0-100. Fund For Peace 2016.

The extent to which a country's citizens are able to participate in selecting their government, as well as freedom of expression, freedom of association and freedom of the press. This is one of the six dimensions of governance measured by the WGI project, taking into account over 200 states and territories

World Governance Indicators 2015.

World Development Indicators 2014.

The likelihood the government will be destabilied by unconstitutional or violent means, including terrorism. This is one of the six dimensions of governance measured by the WGI project, taking into account over 200 states and territories World Governance Indicators 2015.

The quality of public services, the quality of the civil service and its independence from political pressures, the quality of policy formulation and implementation, and the credibility of the government's commitment to its stated policies. This is one of the six dimensions of governance measured by the WGI project, taking into account over 200 states and territories. World Governance Indicators 2015.

Regulatory Quality

Score from 0-100, where 0 = low quality regulation, 100 = high quality regulation Very Low: 0-20 Low: 21-40 Moderate: 41-60 High: 61-80 Very High: 81-100

Rule of Law

Score from 0-100, where 0 = weak rule of law, 100 = strong rule of law Very Low: 0-20 Low: 21-40 Moderate: 41-60 High: 61-80 Very High: 81-100

Control of Corruption

Score from 0-100, where 0 = weak control of corruption, 100 = strong control of corruption Very Low: 0-20 Low: 21-40 Moderate: 41-60 High: 61-80 Very High: 81-100

Peacefulness

Global Peace Index Score from 1 – 3.9, where 1 = peaceful, 3.9 = not peaceful Very Low: 2.87 < 3.9 Low: 2.38 < 2.87 Moderate: 1.91 < 2.38 High: 1.43 < 1.91 Very High: 1 < 1.43 The ability of the government to formulate and implement sound policies and regulations that permit and promote private sector development. This is one of the six dimensions of governance measured by the WGI project, taking into account over 200 states and territories. World Governance Indicators 2015.

The extent to which agents have confidence in and abide by the rules of society, including the quality of contract enforcement and property rights, the police, and the courts, as well as the likelihood of crime and violence. This is one of the six dimensions of governance measured by the WGI project, taking into account over 200 states and territories. World Governance Indicators 2015.

The extent to which public power is exercised for private gain, including both petty and grand forms of corruption, as well as "capture" of the state by elites and private interests. This is one of the six dimensions of governance measured by the WGI project, taking into account over 200 states and territories.

World Governance Indicators 2015.

The GPI measures 164 countries' peacefulness using a broad range of 22 indicators that show the extent to which a country is involved in domestic and international conflict, as well as the level of harmony or discord within a nation. Global Peace Index 2016.

Quality of Natural Resource and Environmental Governance

Environmental Performance Index

Score from 0-100, where 0 = poor, 100 = strong Very Low: 0-20 Low: 21-40 Moderate: 41-60 High: 61-80 Very High: 81-100

Business Anti-Corruption Portal

A method of quantifying and numerically marking the environmental performance of 180 state's policies, taking into account 19 indicators of environmental health and ecosystem vitality. The scores have been rounded to the nearest whole number. Yale EPI.

The BACP offers qualitative business analysis of corruption risks, legislative framework and civil society, specifically regarding how countries govern their natural resources. BACP Country Profiles.

Transparency

Corruption Perceptions Index

Score from 0-100, where 0 = highly corrupt, 100 = very clean Very Low: 0-20 Low: 21-40

Moderate: 41-60 High: 61-80 Very High: 81-100

Open Budget Index

Score from 0-100, where 0 = no transparency, 100 = full transparency Very Low: 0-20 Low: 21-40 Moderate: 41-60 High: 61-80 Very High: 81-100 Published by Transparency International since 1995, the CPI ranks 167 countries by their perceived levels of corruption, as determined by expert assessments and opinion surveys. Corruption Perceptions Index 2015.

The world's only independent, comparative measure of central government budget transparency. The OBI assigns countries covered by the Open Budget Survey a transparency score on a 100-point scale. Open Budget Index Rankings 2015.

Ratification of UN Convention Against

Corruption 2005 Yes (rated as very high)/ No (rated as very low) The OECD Anti-Bribery Convention establishes legally binding standards to criminalize bribery of foreign public officials in international business transactions and provides a host of related measures that make this effective. It is the first and only international anti-corruption instrument focused on the "supply side" of the bribery transaction. OECD.

A multilateral convention negotiated by members of the United Nations. It is the first global legally binding international anti-corruption instrument, aimed at preventing corruption, including domestic and foreign bribery, embezzlement, trading in influence and money laundering. UNODC.

Ease of Doing Business

Ease of Doing Business Index 2016 (Distance to Frontier Score)

Score from 0-100, 0 = poor regulatory environment for doing business, 100 = strong regulatory environment for doing business Very Low: 0-20 Low: 21-40 Moderate: 41-60 High: 61-80 Very High: 81-100

Business Anti-Corruption Portal (BACP) Country Profile The "distance to frontier" score helps assess the absolute level of regulatory performance of 190 economics over time. It measures the distance of each economy to the "frontier," which represents the best performance observed on each of the indicators across all economies in the Doing Business sample since 2005. The index measures regulations directly affecting businesses, based on the study of laws and regulations, with the input and verification by more than 9,600 government officials, lawyers, business consultants, accountants and other professionals in 185 economies who routinely advise on or administer legal and regulatory requirements. Doing Business.

The BACP offers qualitative business analysis of corruption risks, legislative framework and civil society via country profile reports. Where specific country profiles were not available, equivalent information was used from the World Bank and or UK Department of International Trade. Business Anti-Corruption Portal.

Development

Human Development Index (2015 report) High, Moderate, Low according to quartiles. The middle two quartiles are both rated as Moderate. The Human Development Index (HDI) is a composite of indicators related to human development, including life expectancy, education and per capita income. A higher score relates to better overall development and quality of life. UNDP.

Selected Issues

This section utilizes many sources to compile data on environmental, social and governance issues connected with the mining of specific materials in the top producer countries. Sources Include:

Child labor and forced labor

- US Department of Labor

Trade sanctions and embargoes

- US Department of the Treasury
- UK Department of International Trade

Human rights abuses

- Human Rights Watch country profiles
- Amnesty International 2016/7 Annual Report
- Oxfam GB
- Oxfam America
- The Global Initiative

Environmental impacts

- Pure Earth's Toxic Sites Identification Program Global Database

- Greenpeace
- Friends of the Earth

Other/Additional

Extractives sector and investment news, including <u>Mining.com</u>, <u>Investingnews.com</u>, <u>Mining-Journal.com</u>, <u>International</u>, <u>national</u> and regional news, inc. <u>The Guardian</u>, <u>Reuters</u>, <u>Al Jazeera</u>, <u>BBC</u>, <u>Financial Times</u>.

A starting point for collaboration

Besides informing our own next steps, we see this research as a way to increase awareness among our customers and the rest of the industry about the issues in material supply chains, with the aim of improving how consumer electronics are made.

While this report highlights a wide range of social and environmental issues, we don't want to dwell only on the negative. Instead, while the issues mentioned are very serious, there is also an opportunity to explore solutions, make improvements and take action. We hope this document will continue to evolve and serve as a starting point for important conversations and new forms of collaboration.

We therefore encourage everyone to use*, share and build upon this research. If you have any information that you think could contribute to our materials scoping research or improvement efforts, please contact us at research@fairphone.com.

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