Deutsche
Rohstoffagentur

56 DERA Rohstoffinformationen

2023 DERA Criticality List

Supply concentration for mineral resources and their intermediate products – potential price and supply risks

Federal Institute for
Geosciences and
Natural Resources

www.deutsche-rohstoffagentur.de
www.bgr.bund.de

Imprint

Published by:
German Mineral Resources Agency (DERA) at the
Federal Institute for Geosciences and Natural Resources (BGR)
Wilhelmstraße 25–30
13593 Berlin

Authors:
Siyamend Al Barazi, Dennis Bastian, Sophie Damm, Alexander Fritz, Marius Kern, Maren Liedtke, Michael Schmidt

In collaboration with:
Corinna Eicke, Kirsten Moldenhauer

Contact:
German Mineral Resources Agency (DERA) at the
Federal Institute for Geosciences and Natural Resources (BGR)
Wilhelmstraße 25–30
13593 Berlin
Germany
Tel.: +49 30 36993 226
http://www.deutsche-rohstoffagentur.de
dera@bgr.de

Photo credits: © Maxiphoto/iStock
Layout: deckermedia GbR, Graal-Müritz

About this publication: www.bgr.bund.de/DERA_Rohstoffinformationen

Reference: DERA – German Mineral Resources Agency at the Federal Institute for Geosciences and Natural Resources (2023): 2023 DERA Criticality List. – DERA Rohstoffinformationen 56: 122 S., Berlin.

Data status: May 2023

ISBN: 978-3-948532-93-2 (printed version)
ISBN: 978-3-948532-92-5 (pdf)
ISSN: 2193-5319
DOI: 10.25928/3kda-st64

Federal Ministry
for Economic Affairs
and Climate Action

The Federal Institute for Geosciences and Natural Resources is the central geoscientific authority providing advice to the German Federal Government in all geo-relevant questions. It is subordinate to the Federal Ministry for Economic Affairs and Climate Action (BMWK).

2023 DERA Criticality List

Supply concentration for mineral resources and their intermediate products – potential price and supply risks

Contents

List of figures 4

List of tables 5

Summary 6

1. Introduction 9

2. Methodology for the DERA Criticality List 11

3. Risk assessment 14

4. Conclusion 35

5. References 37

Appendix 39

List of figures

Fig. 1: Relative price trends for industrial metals traded on the LME (London Metal Exchange) 10
Fig. 2: Country concentration and weighted country risk of mining output for 2020 15
Fig. 3: Country concentration and weighted country risk of refinery output for 2020 16
Fig. 4: Country concentration and weighted country risk of high-risk commodities (net exports, risk group 3) for 2020 (definitions of HS codes can be found in Table 3 in the Appendix) 17
Fig. 5: Germany's shares of global imports for commodity groups for which Germany is one of the three largest importer countries 26
Fig. 6: Country concentration and weighted country risk for refinery output from primary and secondary aluminium, lead, copper and zinc raw materials for 2020 27
Fig. 7: Herfindahl-Hirschman index (HHI), weighted country risk (WCR) and shares of the three largest mining and refinery producer countries of all resources analysed, and export countries of the commodities with net exports in the critical range for 2020 74
Fig. 8: Herfindahl-Hirschman index (HHI), weighted country risk (WCR) and shares of the three largest refinery producer countries for refinery output from primary and secondary raw materials of aluminium, lead, copper and zinc for 2020 84
Fig. 9: Long-term trends in country concentration (HHI) and weighted country risk (WCR) 101
Fig. 10: Long-term trends in country concentration (HHI) and weighted country risk (WCR) for refinery output from primary and secondary aluminium, lead, copper and zinc raw materials 112
Fig. 11: Main producers of mining and refinery products from raw materials in risk group 3 113
Fig. 12: Main net exporters of products in risk group 3 114

List of tables

Table 1: Mining output, refinery output and commodities (net exports) in risk group 3 and trends for 2018/2020 19
Table 2: Summary analysis of all raw materials studied. Only high-risk commodities (risk group 3) are shown 40
Table 3: Changes in risk of all raw materials analysed and their commodities 85
Table 4: 2020 Worldwide Governance Indicators for major countries 116

Summary

This study reports on a screening of the global supply concentration for a range of raw materials. It presents the country concentration and weighted country risk found in the mining and refinery outputs of 36 metals, 27 industrial minerals and coking coal for the reference year 2020. The study looks at 55 mining products and 29 refinery products (these include refinery products, by-products and ferroalloys). It also determines the country concentration and weighted country risk for 221 commodities based on global net exports. They include ores and concentrates, refinery products and downstream higher-value products. The methodological basis is the 2012 DERA Criticality List (Buchholz et al. 2012). This concept has since been enhanced and, since 2014 (DERA 2014), includes an analysis of commodity net exports. Including commodities in the Criticality List was an important step, which is continued in this current issue.

The study defines three risk groups and assigns the raw materials and commodities analysed to them.

Risk group 1 (low risk) includes raw materials with a non-critical to moderate country concentration and a low weighted country risk, and raw materials with a low country concentration and a moderate weighted country risk. These resources are produced, processed and traded in a range of countries, ensuring broad diversification. Because of the relatively low country risks, political influences are rare, and individual players thus have little opportunity to exercise power in such a market constellation.

Risk group 2 (moderate risk) comprises raw materials with a low country concentration but a high weighted country risk, or a moderate country concentration and moderate weighted country risk. It also includes raw materials with a high country concentration but a low weighted country risk. Supply disruptions are not very likely.

Risk group 3 (high risk) comprises raw materials with a moderate country concentration and a high weighted country risk, and raw materials with a high country concentration and a moderate to high weighted country risk. Supply disruptions in this group are highly likely and price risks particularly high.

– For 46 % (140 of 305) of all mining and refinery products and commodities studied for the 2023 DERA Criticality List, the potential procurement risk was high regarding both the weighted country risk and supply concentration.

– Among the mining products, 40 % (22 of 55) are classified in risk group 3, with only 25 % (14) in the non-critical range. Particularly steel alloying elements, special metals and precious metals (PGMs) are classified as high risk, as well as 26 % (7 of 27) of the industrial minerals studied. China is the largest mining country for 38 % (21) of the mining products, and ranks in second or third place for another 22 % (12). This marks a slight decline compared to 2018 (DERA-Rohstoffliste 2021).

– Among the refinery products, 69 % (20 of 29) are classed in risk group 3. China is the largest producer country for 90 % (26) of refinery products, while Brazil leads in the production of ferroniobium, Chile of rhenium, and New Caledonia (French overseas territory) of ferronickel.

– Of the commodities analysed, 44 % (98 of 221) are in risk group 3, with China the largest net exporter for 32 % (31) of these. This is also a slight drop from 2018.

The mining products classed in risk group 3 (high risk) in 2020 include the steel alloying elements chromium, cobalt, niobium, vanadium, tungsten, the special metals antimony, mercury, rare earths and tantalum, and the precious metals iridium, palladium, platinum, rhodium and ruthenium from the platinum group elements. Seven of the industrial minerals are classed in risk group 3, namely the boron minerals, the kyanite group, fluorspar, graphite, magnesite, the strontium minerals and wollastonite. Coking coal is also classed in risk group 3. New additions to the group are iridium and ruthenium, both included in the DERA Criticality List for the first time. Perlite, on the other hand, is no longer in the high-risk range.

Among the refinery products studied, the following have high potential price and supply risks: alumina, primary aluminium, lead (smelter production), ferrochromium, pig iron, crude steel, gallium (+ production capacity for gallium), germanium, indium, cobalt, magnesium, ferromanganese and ferrosilicomanganese, ferromolybdenum, ferroniobium, rare earths, silicon, titanium, bismuth and tin.

Of the 221 commodities analysed, 98 are classed as having a high potential procurement risk. While 73 of these are metal resources, the remaining 25 are industrial minerals. Nineteen commodity groups are ores and concentrates or raw materials at the start of the value chain, the other 79 are intermediate or higher value added products.

The raw materials in risk group 3 are very easily affected by market changes. Because of the high supply concentration, countries or suppliers dominating a market can exercise their market power. This can lead to distortions of competition, with a detrimental effect on Germany as a manufacturing location. In highly concentrated markets, even minor disruptions in production, or even an anticipated drop in production, can unsettle stakeholders and have a major impact on prices.

Overall, the group of raw materials with a high potential procurement risk comprises 140 products, or 46 % of all raw materials and intermediate products studied. This makes it clear to what extent commodity markets are currently affected by supply concentrations and increased country risks. The results show that, despite slight declines, China in 2020 is still the largest mining country, the main producer of refinery products, and the leading net exporter of intermediate products.

But it is not the only country with a dominant position in the mineral resources markets. Supply concentrations in mining, processing and trade can be found for a number of other raw materials and countries. Examples are the mining of platinum in South Africa or the export of cobalt matte and other intermediate products of cobalt metallurgy (HS 810520) from DR Congo.

To take into account the increasing importance of secondary raw materials in refinery production, this issue of the DERA Criticality List distinguishes for the first time between refinery products from primary and secondary raw materials. The figures show that while European and German producers of refinery products account for an above-average large share of refinery output from secondary raw materials, China is the leading producer of refinery products in absolute figures, both on the primary and the secondary commodity markets.

In 2020, the Covid-19 pandemic resulted in mine closures and cuts in production. This is reflected in the figures of the 2023 DERA Criticality List. For 71 % (39) of the 55 raw materials studied, for in-

stance, mining volumes (mining output) fell compared to 2018, as did refinery output for 41 % (12) of the 29 products studied.

Particularly the small, highly concentrated commodity markets are associated with increased risks for Germany as a manufacturing and technology location. Distortions of competition, trade conflicts, speculation, political interventions and natural disasters can easily turn potential procurement risks into very real price and supply issues.

With the help of this 2023 DERA Criticality List, enterprises can identify resource-specific vulnerabilities in their supply chains and the associated price and supply risks. Companies are advised to review the risk indicators in the DERA Criticality List for the preliminary and intermediate products they use in production, and include these findings in their corporate risk management. We recommend that German enterprises assess their procurement strategies for potentially critical raw materials along the supply chain, and develop alternative strategies where required.

1. Introduction

Mineral resources are at the starting point of the industrial value chain. They are the basic building blocks of production for every sector, from primary to high-tech industry. Germany therefore depends on a secure and ecologically and economically sustainable supply of the necessary resources for its competitiveness as a location for industry and technology.

This study, the 2023 DERA Criticality List, forms part of DERA's raw materials monitoring. It is the sixth issue since 2012. Enterprises can use the DERA Criticality List to identify potential risks in their supply chains for mineral resources. At the same time, the list should encourage more in-depth market analysis for individual resources, in order to develop suitable alternative and diversification strategies for raw material procurement. Germany is very heavily dependent on commodity imports, particularly of metal resources, which is why the monitoring and analysis of global commodity markets are crucial.

Since the start of the pandemic in 2020, the extractive and mineral processing industries in Europe have faced a large number of problems, ranging from high energy prices to interrupted supply chains and to a reconfiguration of existing supply relationships.

The measures taken globally to contain the Covid-19 pandemic led to a significant slump in industrial production in 2020 and a corresponding fall in raw material demand. Impacts of the pandemic on the mining sector included temporary mine closures and cuts in production. This is reflected in the figures of the 2023 DERA Criticality List. One example is South Africa. A combination of the measures taken to control the spread of Covid-19 in the country and technical challenges resulted in a considerable drop in the production of platinum group metals (PGM) from 2019 to 2020 (platinum –26 %, rhodium –21 % and palladium –24 %) (Johnson & Matthey 2022). In 2020, South Africa accounted for around 65 % of the global output of platinum, 32 % of global palladium and 79 % of global rhodium output (Johnson & Matthey 2022). This share was lower than in 2019. In the following years 2021 and 2022, PGM output rose again, reaching the 2019 level.

From April 2020, raw material demand and prices increased once more. By the start of 2021, prices for the major industrial metals had recovered from the 2020 slump caused by the pandemic, reaching and even exceeding the pre-pandemic level (Fig. 1). As a result of the rapid economic recovery of the PR China, and consequently a rise in demand for raw materials, prices increased. At the same time, the situation in international shipping escalated. A lack of freight containers in China, fully used freight capacities and delays in the unloading of goods in European and US-American ports led to higher freight rates and late deliveries. For enterprises in Europe, this became more and more of a problem, as many raw materials and preliminary products have to be imported.

In the second half of 2021, rising energy prices caused some European operators of smelting plants to slow production, affecting, in particular, ferroalloys, steel, zinc and aluminium. By today, in the first half of 2023, around half of European production capacities for aluminium have been taken off the market. Further pressures in the form of falling European supply now came on top of the higher freight rates and late deliveries. A direct result were significant outflows of metals from the London Metal Exchange's European stocks, which are now at their lowest level for several years.

These were the many challenges facing the mineral processing industry in Europe when Russia's invasion of Ukraine in spring 2022 exacerbated the situation. The Russian Federation is a major supplier of both energy and metal resources. In 2020, around 44 % of German imports of nick-

el and 20 % of raw aluminium originated from Russia. The interruption of raw material supply chains put additional strain on German and European enterprises. Supply relationships established over many years have had to be restructured.

Enterprises have been trying to source raw materials they previously imported from Russia elsewhere, partly because it has become difficult to organise financing and transactions for Russian resources via European banks. As a result, raw materials from sources outside Russia have been traded at a considerable premium, further increasing raw material costs for European enterprises.

The price and supply situation on the international commodity markets has already affected the resources situation in Germany. In 2021, Germany imported around 399 m t of energy, metal and non-metal resources, 3 % more than in 2020. Because of the considerable rise in prices for raw materials, the value of these imports increased by about €70bn compared to the previous year to €211bn. And while raw material import volumes in 2021 were 5.5 % lower than in 2019, import costs rose by €37bn because of the price increase (BGR 2022).

With its dependence on raw materials, the manufacturing industry in Europe today continues to face major challenges such as volatile commodity prices, a decline in output from European smelting plants and high energy costs. A diversification of the supply chain and the development of European supply chains appear to be more important than ever.

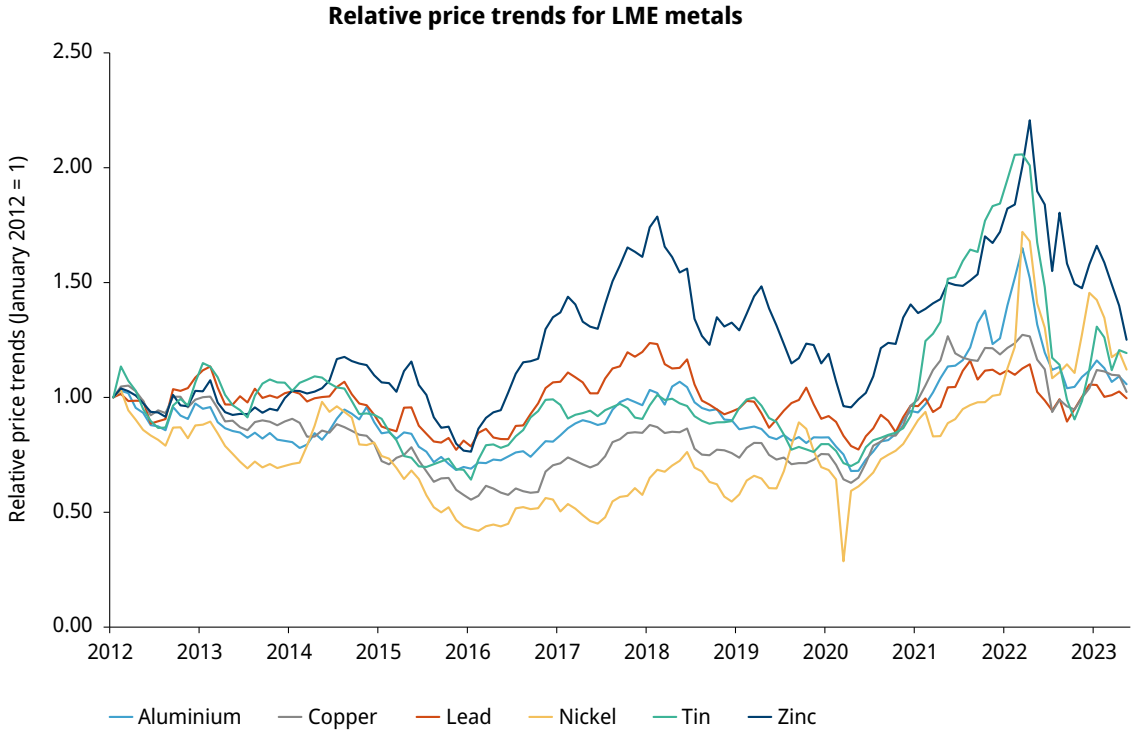


Fig. 1: Relative price trends for industrial metals traded on the LME (London Metal Exchange)

2. Methodology for the DERA Criticality List

This study represents a statistical evaluation of data from the mineral raw materials database of the Federal Institute for Geosciences and Natural Resources (BGR 2021) and commercial databases. It does not replace detailed market analyses, but instead provides a comparative overview of supply concentration and weighted country risk in mining output, refinery output and in net exports of commodities at different levels of the value chain.

The current study considers 36 metals, 27 industrial minerals, coking coal and 221 commodities. Unless stated otherwise, the reference year for all data is 2020 and the data status is May 2023. A comparison of the findings of the 2023 DERA Criticality List with issues from previous years must take into account that BGR continuously reviews and revises the raw material data in its database. The data are thus subject to continuous changes. Consequently, the market data and thus the supply concentration and weighted country risk for some mineral resources have changed for the reference year 2018 used in the previous study.

This study also includes the developments in country concentration (from 1960 depending on data availability) and the weighted country risk (from 2000) for mining output and refinery output (Appendix Fig. 9).

Since the output volumes of intermediate products along the value chain are often not recorded consistently, export data for the traded commodities are used to analyse them instead. With the support of the Federation of German Industries (Bundesverband der Deutschen Industrie, BDI), DERA carried out a survey of the relevant commodity groups based on the nomenclature of the Harmonized System (HS Codes) in 2014, to identify the most important intermediate products.

For the calculation of net exports, we used the Global Trade Tracker developed by ZEN Innovations AG (ZEN Innovations AG 2023), unlike in 2021 (Global Trade Atlas, IHS Markit).

Our analysis of global supply concentration was based on calculations of the Herfindahl-Hirschman index (HHI). The weighted country risk (WCR) was obtained using the World Bank's Worldwide Governance Indicators (WGI). To determine the HHI and WCR for the commodities, we used global net exports.

Data availability and quality often vary considerably between the individual raw materials considered. Availability is often inadequate, particularly for special metals such as gallium, germanium, indium, selenium and bismuth, which are often extracted as by-products of a main element, and also for some industrial minerals.

Country concentration (Herfindahl-Hirschman index)

Since the mid-1970s, BGR has published several reports on global concentration in mining output (Schmidt & Kruszona 1975, 1982, Wellmer et al. 1996, Eggert et al. 2000, Wagner et al. 2005). They used the three largest mining countries' cumulative share of global mining output as a measure of concentration, while Wagner et al. (2005) also included the five and ten largest mining countries' shares (CR_3, CR_5, CR_{10}). This methodology has only limited information value. It permits no conclusions regarding the size distribution of market participants within the group captured nor does it provide information about any market participants not considered. That is why the DERA Criticality List uses the Herfindahl-Hirschman index (HHI) as the absolute measure of concentration based on output volumes.

The Herfindahl-Hirschman index is defined as the sum of the squared market shares of all competitors in the market. Its value range is 1/[number of market participants] ≤ HHI ≤ 1. The lower limit is reached when each market participant has the same share. Markets with only one participant, i.e. monopolies, have an HHI of 1. Markets with many participants can have very small index values, which is why the HHI is often multiplied by 10,000 for practical reasons.

In their Horizontal Merger Guidelines (U.S. Department of Justice 2010), the U.S. Department of Justice and the Federal State Commission define markets with an HHI below 1,500 as being unconcentrated and those with an index value of between 1,500 and 2,500 as moderately concentrated. Markets with an HHI above 2,500 are considered highly concentrated.

Weighted country risk

The weighted country risk (WCR) for mining output, refinery output and net exports is calculated by weighting each country's output and net export shares with an index or country ranking. A tried and tested system for this are the Worldwide Governance Indicators (WGI) of the World Bank Group. Every year, the World Bank rates the governance of over 200 countries based on a set of six indicators (World Bank 2022). These indicators are composed as outlined below.

- **Voice and accountability:** This indicator captures to what extent a country's citizens are able to participate in selecting their government, taking into account the factors freedom of expression, freedom of association, and a free media.
- **Political stability and absence of violence:** This indicator expresses the likelihood of political instability and/or politically-motivated violence, including terrorism.
- **Government effectiveness:** This assesses the quality of public services, the quality of the civil service and the degree of its independence from political pressures.
- **Regulatory quality:** This indicator rates the ability of the government to formulate and implement sound policies and regulations that permit and promote private sector development.
- **Rule of law:** This indicator assesses 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 courts, and the police, as well as the likelihood of crime and violence.
- **Control of corruption:** This indicator rates 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.

By aggregating and averaging all six indicators, a country risk score in the range +2.5 to –2.5 results (Table 3). Countries with poor governance have a negative WGI score and countries with good governance, a positive score. To calculate the weighted country risk, the countries' WGI scores are weighted with their respective share of global mining output, refinery output or net export volume, and summed. The resulting weighted country risk (WCR) generally ranges from +1.0 to –1.0. Scores below 0.5 a considered as low risk. A moderate risk has scores between +0.5 and –0,5, while WCR scores below –0.5 are considered as high risk (Rosenau-Tornow et al. 2009, Buchholz et al. 2012a, 2012b).

Commodities and determining net exports

Supply concentration in international trade is analysed based on the net exports of commodities from different levels of the value chain. Net exports are defined as the difference between a country's exports and imports. By using net exports instead of pure export data, double

counts can be largely eliminated and countries excluded that act primarily as trade hubs (e. g., Rotterdam). Net exports can be positive or negative. The DERA Criticality List uses only positive net exports for the individual commodities, since the focus is on the supply side. Negative net exporters, on the other hand, are consumer countries of a raw material. The sum of positive net exports consequently represents the output volumes that enter international trade.[1] We analysed data on 221 commodities. As with mining output and refinery output, we calculated the country concentrations and the weighted country risks for 2020. Table 3 in the Appendix provides an overview of all commodities analysed.

Starting with the publication of the 2023 DERA Criticality List, and thus departing from the 2021 approach, the data used for our analysis of international trade in raw materials and intermediate products originates from the Global Trade Tracker. This commercial database currently has monthly statistical data entries for 129 countries (ZEN Innovations AG 2023), and annual data for 73 countries. International trade uses the Harmonized System (HS) for the classification of goods into specific commodity groups. Managed by the World Customs Organization (WCO), the system currently comprises more than 5,000 commodity groups (WCO 2023). It aims to provide unique labels and codes for a standardised global classification of goods. The HS is used by governments, international organisations and industry for the purpose of levying taxes and freight tariffs, price monitoring, quota control, rules of origin, and the collection of transport and trade statistics (WCO 2023).

Harmonized System (HS) codes consist of six digits. More digits can be added to an HS code at country level, but these national codes are not managed by the WCO.

The HS often groups individual product specifications together, making it impossible to track the trade in these specifications individually in the HS. In such cases, reference must be made to the relevant extended national codes. An example: the HS classifies tungsten oxides and tungsten hydroxides together with other intermediate products under heading 282590. The Combined Nomenclature (CN) of the European Union, however, lists tungsten oxides and tungsten hydroxides separately under CN code 282590.40. For ten commodity groups (Table 2 and Table 3), the 2023 DERA Criticality List refers to national codes.

Theoretically the sum of global imports should be equal to the sum of global exports. But for around 62 of the commodities analysed, there were quite significant discrepancies between global exports and global imports. The reasons for this are complex. For some countries, trade data are generally not available, although they are major supplier countries of certain raw materials. There are, for instance, no official data for exports of cobalt ores and concentrates from DR Congo, although around 96 % of global imports in 2020 originated there. Moreover, some countries choose not to disclose exports and imports of certain goods for data protection reasons, or they report only incomplete or no data (examples are Australia, Russia, Austria, Germany or China). Export restrictions and quotas also play a major role in this context. As in 2018, one example is antimony. According to official figures, China exported around 8,260 t of antimony metal in 2020. But in the same year, about 37,500 t of antimony metal were imported from China. Another source of error are incorrectly declared commodity groups and double counts. We ran plausibility checks on commodity groups with discrepancies of more than 15 % between global imports and exports. Where necessary, net exports were then determined using mirror data (global imports from a specific country). Commodity groups whose global net exports are derived in this way are marked accordingly in Table 2 and Table 3.

[1] Mining output is generally given in raw material content, while net export values include uneconomical material.

3. Risk assessment

This section provides an analysis of the country concentration (HHI) and the weighted country risk (WCR) for mining output, refinery output, and net exports of commodities. Unlike mining output and refinery output, only those commodities with a high risk (risk group 3) are listed.

Country concentration and weighted country risk

The charts in Figures 2 to 4 show the determined country concentration and weighted country risk of mining output, refinery output and net exports of commodities for 2020. We differentiate three risk groups (RG):

Risk group 1, low risk:
This group is divided into two (Fig. 2 and Fig. 3, green section):

– Resources with a non-critical to moderate country concentration (HHI < 2,500) and a low weighted country risk (WCR > 0.5). Garnet mining output is in this range. Of the commodities analysed, 55 are found in this range.

– Resources with a non-critical supply concentration (HHI < 1,500) and a moderate weighted country risk (WCR +0.5 to –0.5). This section of risk group 1 includes the mining output of the metals gold, copper, nickel, silver, titanium and the industrial minerals bentonite, pumice, gypsum/anhydrite, garnet, kaolin, halite, talcum and zeolite and the refinery product ferronickel. It also includes 15 of the commodities analysed.

Risk group 1 now includes the mining products pumice, garnet and talcum (RG 2 in the previous Criticality List, 2018 data) and the refinery product ferronickel (new addition to the DERA Criticality List; data for 2018 also show a low risk). The group no longer includes the mining products iron ore, mica and zirconium and the refinery products ferromanganese, refined nickel and selenium (now RG 2).

Gold mining output can be used as a representative example of this group, with a broadly diversified market and low potential price and supply risks: alongside the three main producers (China, Australia and Russia), the remaining output is shared by 90 other countries. As a result, the market power of individual producers and thus the weighted country risk are low.

Risk group 2, moderate risk:
This group is divided into three (Fig. 2 and Fig. 3, yellow section):

– Resources with a moderate country concentration (HHI 1,500 to 2,500) and a moderate weighted country risk (WCR +0.5 to –0.5). This includes the mining output of the ores of the metals aluminium (bauxite), lead, iron, manganese, molybdenum, zinc and tin, and of the industrial minerals baryte, diamonds, feldspar, mica, potash, perlite, phosphate, pyrophyllite, vermiculite and zirconium. The refinery output of lead, cadmium, copper, ferromanganese, nickel, selenium and zinc is also included in this risk range. Of the 221 commodities analysed, 25 are found in this range.

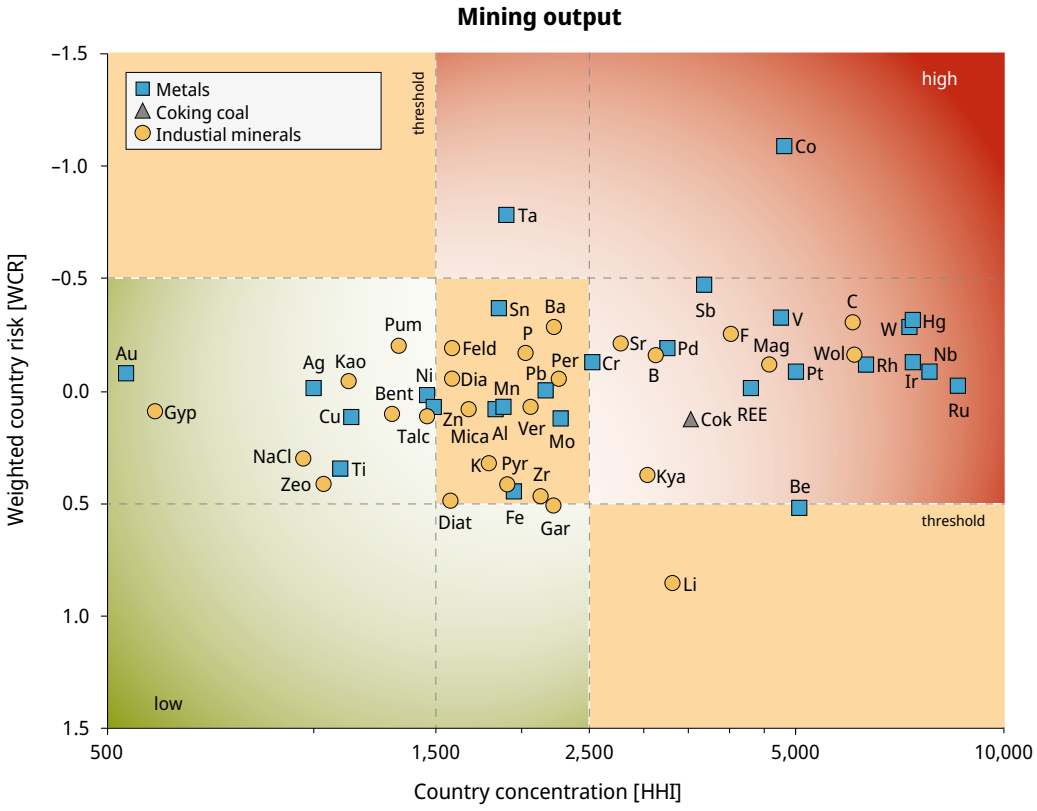
– Resources with a high country concentration (HHI > 2,500) and a low weighted country risk (WCR > 0.5). The mining output of beryl and lithium, the refinery output of rhenium, and 43 of the commodities studied are in this range.

– Resources with a non-critical country concentration (< 1,500) but a high weighted country risk (WCR < -0.5). None of the resources analysed are found in this range.

New additions to risk group 2 are the mining products iron ore, mica, zirconium (previously

RG 1) and perlite (previously RG 3), and the refinery products ferromanganese, refined nickel and selenium (previously RG 1). Pumice, garnet and talcum are no longer in RG 2 (now in RG 1), and neither is the refinery product ferrochromium (now RG 3).

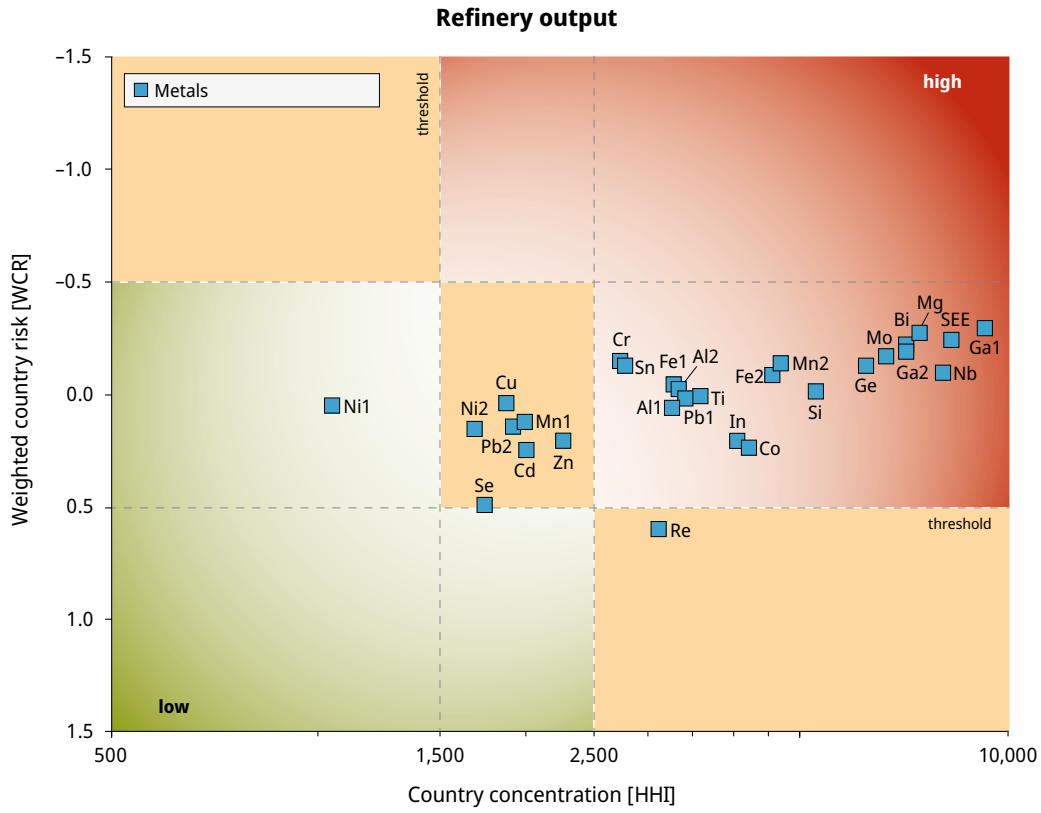
Given the relevance of the topic battery storage, lithium can be cited as an example. It clearly illustrates how the DERA Criticality List with its range of risk indicators should be used: supply concentration for lithium is high (HHI 3,331), because production is largely limited to Austra-



= Risk group 1 = Risk group 2 = Risk group 3

Metals and Coking coal				Industrial minerals			
Ag:	Silver	Pb:	Lead	B:	Boron minerals	Mag:	Magnesite
Al:	Bauxite (aluminium)	Pd:	Palladium	Ba:	Baryte	Mica:	Mica
Au:	Gold	Pt:	Platinum	Bent:	Bentonite	NaCl:	Halite
Be:	Beryl	REE:	Rare earth	C:	Graphite	P:	Phosphate
Co:	Cobalt	Rh:	Rhodium	Dia:	Diamonds	Per:	Perlite
Cr:	Chromium ore	Ru:	Ruthenium	Diat:	Diatomite	Pum:	Pumice
Cu:	Copper	Sb:	Antimony	F:	Flurspar	Pyr:	Pyrophyllite
Fe:	Iron	Sn:	Tin	Feld:	Feldspar	Sr:	Strontium minerals
Hg:	Mercury	Ta:	Tantalum	Gar:	Garnet	Talc:	Talcum
Ir:	Iridium	Ti:	Titanium	Gyp:	Gypsum/anhydrite	Ver:	Vermiculite
Mn:	Manganese	V:	Vanadium	K:	Kyanite group	Wol:	Wollastonite
Mo:	Molybdenum	W:	Tungsten	Kao:	Kaolin	Zeo:	Zeolite
Nb:	Niobium	Zn:	Zinc	Kya:	Kyanite group	Zr:	Zirconium
Ni:	Nickel	Cok:	Coking coal	Li:	Lithium		

Fig. 2: Country concentration and weighted country risk of mining output for 2020



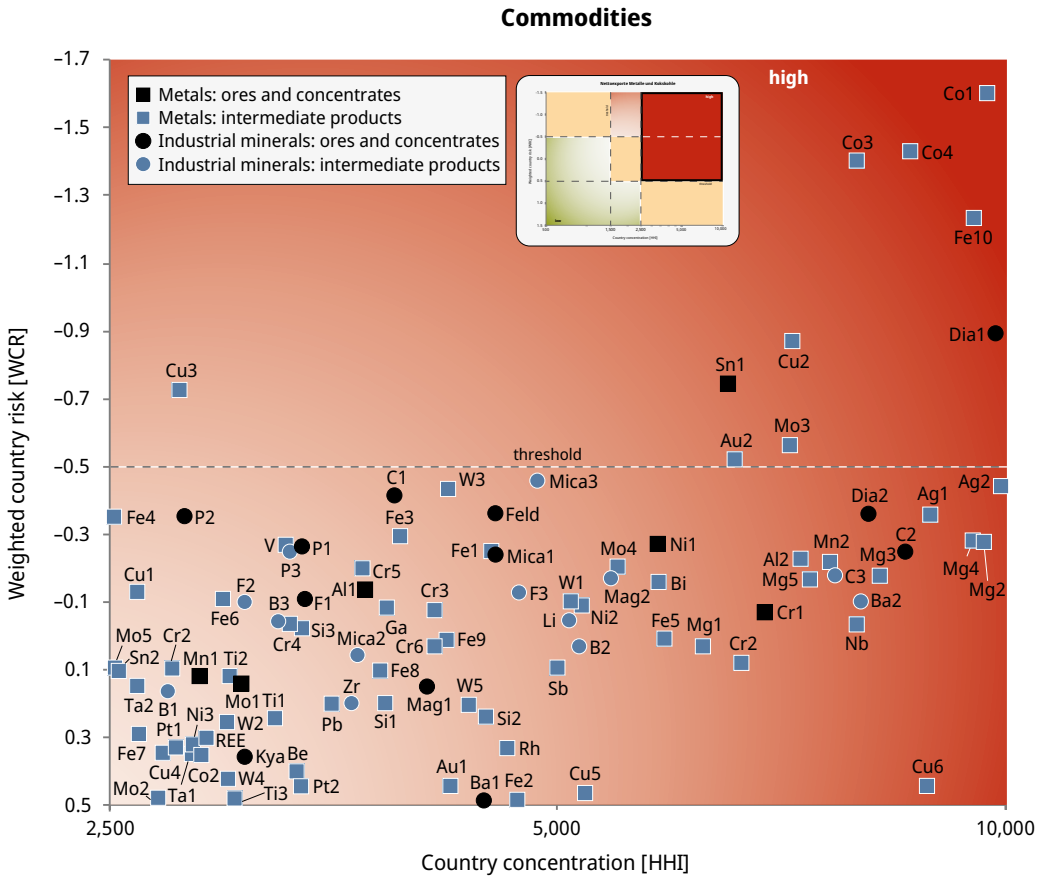
Al1:	Alumina	Fe2:	Pig iron	Mo:	Ferromolybdenum	Se:	Selenium
Al2:	Primary aluminium	Ga1:	Gallium	Nb:	Ferroniobium	Si:	Silicon
Bi:	Bismuth	Ga2:	Gallium (capacity)	Ni1:	Ferronickel	Sn:	Tin (smelter production)
Cd:	Cadmium	Ge:	Germanium	Ni2:	Refined nickel	Ti:	Titanium metal
Co:	Refined copper	In:	Indium	Pb1:	Lead (smelter production)	Zn:	Refined zinc
Cr:	Ferrochromium	Mg:	Magnesium	Pb2:	Refinded lead		
Cu:	Refined copper	Mn1:	Ferromanganese	Re:	Rhenium		
Fe1:	Crude steel	Mn2:	Ferromanganese + Ferrosilicomanganese	REE:	Rare earths		

Fig. 3: Country concentration and weighted country risk of refinery output for 2020

lia (WGI 1.48) and Chile (WGI 0.81) (share: approx. 75 %). Nevertheless, the potential overall procurement risks should be classed as moderate, because of the low weighted country risk (WCR 0.87). This is based on the assumption that states with good governance are less likely to take anti-competitive unilateral measures in the raw materials industry and are therefore reliable suppliers. Although supply concentration is high, lithium is therefore classed in risk group 2.

Risk group 3, high risk:
The resources in risk group 3 have the highest price and supply risks. This group is divided into two (Fig. 2, Fig. 3, and Fig. 4, red section):

– Resources with a moderate country concentration (HHI 1,500 to 2,500) and a high weighted country risk (WCR < –0.5). In 2020, only tantalum mining output was found in this range.



= Risk group 3

Metals

Ag1:	HS 710610	Cr4:	HS 720241	Fe7:	HS 720299	Mo4:	HS 810294	Sn1:	HS 260900
Ag2:	HS 710691	Cr5:	HS 720250	Fe8:	HS 720390	Mo5:	HS 810297	Sn2:	HS 800110
Al1:	HS 260600	Cr6:	HS 811221	Fe9:	HS 720510	Nb:	HS 720293	Ta1:	HS 810320
Al2:	HS 281810	Cu1:	HS 740200	Fe10:	HS 720610	Ni1:	HS 260400	Ta2:	HS 810390
Au1:	HS 284330	Cu2:	HS 740312	Ga:	HS 811292	Ni2:	HS 720260	Ti1:	HS 282300
Au2:	HS 710812	Cu3:	HS 740319	Mg1:	HS 283321	Ni3:	HS 750210	Ti2:	HS 720291
Be:	HS 811212	Cu4:	HS 740329	Mg2:	HS 810411	Pb:	HS 282490	Ti3:	HS 810820
Bi:	HS 810600	Cu5:	HS 740610	Mg3:	HS 810419	Pt1:	HS 711011	V:	HS 282530
Co1:	HS 260500	Cu6:	HS 740620	Mg4:	HS 810430	Pt2:	HS 711292	W1:	HS 282590
Co2:	HS 282200	Fe1:	HS 260120	Mg5:	HS 810490	REE:	HS 284610	W2:	HS 284180
Co3:	HS 810520	Fe2:	HS 261800	Mn1:	HS 260200	Rh:	HS 711031	W3:	HS 284990
Co4:	HS 810590	Fe3:	HS 282110	Mn2:	HS 811100	Sb:	HS 282580	W4:	HS 720280
Cr1:	HS 261000	Fe4:	HS 720110	Mo1:	HS 261390	Si1:	HS 280469	W5:	HS 810194
Cr2:	HS 281910	Fe5:	HS 720120	Mo2:	HS 282570	Si2:	HS 281122		
Cr3:	HS 281990	Fe6:	HS 720150	Mo3:	HS 284170	Si3:	HS 284920		

Industrial minerals

B1:	HS 281000	C1:	HS 250410	F1:	HS 252921	Li:	HS 282520	Mica3:	HS 252530
B2:	HS 284019	C2:	HS 250490	F2:	HS 282922	Mag1:	HS 251910	P1:	HS 251010
B3:	HS 284020	C3:	HS 380110	F3:	HS 281111	Mag2:	HS 251990	P2:	HS 251020
Ba1:	HS 251120	Dia1:	HS 710221	Feld:	HS 252910	Mica1:	HS 252510	P3:	HS 310530
Ba2:	HS 283327	Dia2:	HS 710231	Kya:	HS 250850	Mica2:	HS 252520	Zr:	HS 810920

Fig. 4: Country concentration and weighted country risk of high-risk commodities (net exports, risk group 3) for 2020 (definitions of HS codes can be found in Table 3 in the Appendix)

– Resources with a high country concentration (HHI > 2,500) and a moderate to high weighted country risk (WCR < 0.5). This group includes mining output of the metals antimony, chromium, iridium, cobalt, niobium, palladium, platinum, mercury, rhodium, ruthenium, rare earths, vanadium and tungsten. The industrial minerals with mining output in the section with high procurement risks are boron minerals, minerals of the kyanite group, fluorspar, graphite, magnesite, the strontium minerals and wollastonite. The group also includes the mining output of coking coal.

– More than two thirds of all refinery products analysed have a high potential procurement risk. They are alumina, primary aluminium, lead (smelter production), pig iron, crude steel, the refinery products of cobalt, magnesium, rare earths, silicon, titanium and tin; the ferroalloys ferrochromium, ferromanganese and ferrosilicomanganese, ferromolybdenum, ferroniobium; and the metal by-products gallium, germanium, indium and bismuth (Fig. 3, red section).

A new addition to risk group 3 in 2020 is the refinery product ferrochromium. The platinum group elements iridium and ruthenium are new in the DERA Criticality List, although they were already in risk group 3 in 2018. Group 3 no longer includes the mining product perlite (now RG 2).

Of the 221 commodities analysed (net exports), 98 are in risk group 3. They include 19 ores and concentrates or primary raw materials, and 79 intermediate or higher value added products (Table 1 and Fig. 4, red section).

In the group of ores and concentrates (mining products), supply concentration is still very high and the weighted country risk is high for the trade in cobalt ores and concentrates (HS 260500), chromium ores and concentrates (HS 261000), graphite (HS 25490), and tin ores and concentrates (HS 260900).

Refinery products with a high potential procurement risk include, for instance, unwrought magnesium (HS 810411, HS 810419), cobalt matte and other intermediate products (HS 810520), ferroniobium (HS 720293), molybdates (HS 284170) and sulphates of barium (HS 283327) and artificial graphite (HS 380110).

Among the intermediate products, supply concentration and the weighted country risk are high for iron and non-alloy steel (HS 720610), magnesium raspings, turnings and granules (HS 810430), articles of cobalt (HS 810590), articles of bismuth (HS 810600), articles of manganese (HS 8111100) and magnesia (HS 251990).

Table 1: Mining output, refinery output and commodities (net exports) in risk group 3 and trends for 2018/2020

Raw materials	Specification	WCR	HHI	Trend (HHI)
Aluminium	Alumina output	0.11	3,304	→
	Refinery output	0.02	3,367	→
	Aluminium ores and concentrates (HS 260600[1)])	–0.13	3,699	↗
	Corundum, artificial, whether or not chemically defined (HS 281810)	–0.22	7,301	↑
Antimony	Mining output	–0.46	3,717	→
	Antimony oxides (HS 282580)	0.10	5,012	↗
Baryte	Natural barium carbonate (witherite), whether or not calcined (excl. barium oxide) (HS 251120[1)])	0.49	4,468	↗
	Sulphates of barium (HS 283327[1)])	–0.09	8,002	↗
Beryllium	Unwrought beryllium; beryllium powders (HS 811212[1)])	0.40	3,285	↑
Bismuth	Refinery output	0.18	7,221	↑
	Bismuth and articles thereof, n. e. s.; bismuth waste and scrap (excl. ash and residues containing bismuth) (HS 810600[1)])	0.15	5,899	↑
Boron minerals	Mining output	–0.16	3,235	↘
	Oxides of boron; boric acids (HS 281000[1)])	0.17	2,744	→
	Disodium tetraborate (refined borax) (excl. anhydrous) (HS 284019[1)])	0.04	5,186	↘
	Borates (excl. disodium tetraborate [refined borax]) (HS 284020[1)])	–0.04	3,255	→
Chromium	Mining output	–0.11	2,559	↘
	Ferrochromium output	–0.11	2,781	↗
	Chromium ores and concentrates (HS 261000)	–0.06	6,916	↑
	Chromium trioxide (HS 281910[1)])	0.09	2,705	↘
	Chromium oxides and hydroxides (excl. chromium trioxide) (HS 281990[1)])	–0.08	4,134	→
	Ferrochromium, containing by weight > 4 % of carbon (HS 720241)	–0.03	3,315	↘
	Ferrosilicochromium (HS 720250)	–0.18	3,742	↓
	Unwrought chromium; chromium powders (HS 811221)	0.04	4,118	↗
Cobalt	Mining output	–1.07	4,829	↘
	Refinery output	0.29	4,277	↗

Raw materials	Specification	WCR	HHI	Trend (HHI)
Cobalt	Cobalt ores and concentrates (HS 260500[1)])	–1.57	9,787	↗
	Cobalt oxides and hydroxides; commercial cobalt oxides (HS 282200[1)])	0.36	2,891	↑
	Cobalt mattes and other intermediate products of cobalt metallurgy; unwrought cobalt; cobalt powders (HS 810520[1)])	–1.39	7,956	→
	Articles of cobalt (n. e. s.) (HS 810590[1)])	–1.42	8,652	↑
Coking coal	Mining output	0.14	3,527	↗
Copper	Copper, unrefined; copper anodes for electrolytic refining (HS 740200[1)])	–0.12	2,618	↘
	Copper, refined, in the form of wire-bars (HS 740312[1)])	–0.86	7,226	↑
	Copper, refined, unwrought (excl. copper in the form of billets, wire-bars, cathodes and sections of cathodes) (HS 740319)	–0.72	2,792	↑
	Copper alloys unwrought (excl. copper-zinc base alloys [brass], copper-tin base alloys [bronze] and copper master alloys of heading 7405) (HS 740329[1)])	0.35	2,724	↗
	Copper powders, of non-lamellar structure (excl. grains of copper) (HS 740610)	0.47	5,219	↑
	Copper powders, of lamellar structure, and flakes of copper (excl. grains of copper and spangles of heading 8308) (HS 740620)	0.45	8,883	↗
Diamonds	Industrial diamonds unworked or simply sawn, cleaved or bruted (HS 710221[1)])	–0.88	9,865	→
	Non-industrial diamonds unworked or simply sawn, cleaved or bruted (excl. industrial diamonds) (HS 710231[1)])	–0.35	8,112	↑
Feldspar	Feldspar (HS 252910)	–0.35	4,579	↘
Fluorspar	Mining output	–0.24	4,055	→
	Fluorspar containing by weight ≦ 97 % calcium fluoride (HS 252921[1)])	–0.10	3,389	↗
	Fluorspar containing by weight > 97 % calcium fluoride (HS 252922[1)])	–0.09	3,092	↗
	Hydrogen fluoride (hydrofluoric acid) (HS 281111)	–0.12	4,728	↗
Gallium	Primary gallium output	–0.25	9,401	→
	Production capacity primary gallium	–0.15	7,204	→

Raw materials	Specification	WCR	HHI	Trend (HHI)
Gallium	Unwrought hafnium, niobium (columbium), rhenium, gallium, indium, vanadium and germanium; powders and waste and scrap of these metals (excl. ash and residues) (gallium) (HS 811292[1,2])	–0.08	3,848	
Germanium	Refinery output (by-products)	–0.08	6,297	
Gold	Gold compounds, inorganic or organic, whether or not chemically defined (HS 284330[1])	0.45	4,247	
	Gold (incl. gold plated with platinum), unwrought, for non-monetary purposes (excl. gold in powder form) (HS 710812)	–0.51	6,596	
Graphite	Mining output	–0.29	6,074	
	Natural graphite in powder or in flakes (HS 250410[1])	–0.41	3,896	
	Natural graphite (excl. in powder or in flakes) (HS 250490[1])	–0.24	8,580	
	Artificial graphite (excl. retort graphite, retort carbon and goods of artificial graphite, incl. refractory materials based on artificial graphite) (HS 380110[1])	–0.17	7,700	
Indium	Refinery output (by-products)	0.25	4,100	
Iridium	Mining output	–0.11	7,380	
Iron	Crude steel output	–0.04	4,624	
	Pig iron output	0.00	3,314	
	Roasted iron pyrites (HS 260120)	–0.24	4,528	
	Granulated slag (slag sand) from the manufacture of iron or steel (HS 261800)	0.49	4,710	
	Iron oxides and hydroxides (HS 282110)	–0.29	3,916	
	Non-alloy pig iron in pigs, blocks or other primary forms, contain-ing, by weight, ≦ 0.5 % of phosphorus (HS 720110)	–0.34	2,525	
	Non-alloy pig iron in pigs, blocks or other primary forms, contain-ing, by weight, > 0.5 % of phosphorus (HS 720120[1])	0.02	5,910	
	Alloy pig iron and spiegeleisen, in pigs, blocks or other primary forms (HS 720150)	–0.10	2,988	
	Ferroalloys (excl. ferromanganese, ferrosilicon, ferrosilicomanganese, ferrochromium, ferrosilicochromium, ferronickel, ferromolybdenum, ferrotungsten, ferrosilicotungsten, ferrotitanium, ferrosilicotitanium, ferrovanadium and ferroniobium) (HS 720299)	0.30	2,622	

Raw materials	Specification	WCR	HHI	Trend (HHI)
Iron	Spongy ferrous products, obtained from molten pig iron by atomisa-tion, iron of a purity of ≧ 99.94 % (in lumps, pellets or similar forms) (HS 720390[1)])	0.11	3,807	→
	Granules, of pig iron, spiegeleisen, iron or steel (excl. granules of ferroalloys, turnings and filings of iron or steel) (HS 720510[1)])	0.02	4,248	↑
	Ingots, of iron and non-alloy steel (excl. remelted scrap ingots, con-tinuous cast products, iron of heading 7203) (HS 720610)	–1.22	9,554	↗
Kyanite group	Mining output	0.39	3,068	↗
	Andalusite, kyanite and sillimanite (HS 250850)	0.35	3,089	↘
Lead	Lead (smelter production) output	0.06	3,459	↑
	Lead oxides (excl. monoxide [litharge, massicot]) (HS 282490[1)])	0.21	3,534	↑
Lithium	Lithium oxide and hydroxide (HS 282520)	–0.04	5,107	↗
Magnesite	Mining output	–0.10	4,616	↗
	Natural magnesium carbonate (magnesite) (HS 251910)	0.16	4,092	↗
	Fused magnesia; dead-burned (sintered) magnesia, whether or not containing small quantities of other oxides added before sintering; other magnesium oxide (HS 251990)	–0.16	5,441	↗
Magnesium	Refinery output	–0.23	7,568	→
	Sulphates of magnesium (HS 283321)	0.04	6,283	→
	Unwrought magnesium, containing ≧ 99.8 % by weight of magne-sium (HS 810411)	–0.27	9,704	→
	Unwrought magnesium, containing < 99.8 % by weight of magnesi-um (HS 810419)	–0.17	8,219	↗
	Magnesium raspings, turnings and granules; magnesium powders (HS 810430[1)])	–0.27	9,538	↘
	Articles of magnesium (n. e. s.) (HS 810490[1)])	–0.16	7,399	↑
Manganese	Ferromanganese + ferrosilicomanganese output	–0.10	4,755	↑
	Manganese ores and concentrates, incl. ferrugi-nous manganese ores and concentrates, with a manganese content of ≧ 20 %, calculated on the dry weight (HS 260200[1)])	0.12	2,884	→
	Manganese and articles thereof, n. e. s.; manganese waste and scrap (excl. ash and residues containing manganese) (HS 811100)	–0.21	7,646	↘

Raw materials	Specification	WCR	HHI	Trend (HHI)
Mercury	Mining output	–0.30	7,385	↑
Mica	Crude mica and mica rifted into sheets or splittings (HS 252510[1)])	–0.23	4,545	↘
	Mica powder (HS 252520)	0.06	3,672	→
	Mica waste (HS 252530)	–0.45	4,863	↘
Molybdenum	Ferromolybdenum output	–0.13	6,763	→
	Molybdenum ores and concentrates (excl. roasted) (HS 261390)	0.15	3,075	↘
	Molybdenum oxides and hydroxides (HS 282570)	0.49	2,685	↗
	Molybdates (HS 284170[1)])	–0.55	7,176	↑
	Unwrought molybdenum, incl. bars (rods) obtained simply by sintering (HS 810294)	–0.20	5,497	↓
	Molybdenum waste and scrap (excl. ash and residues containing molybdenum) (HS 810297)	0.10	2,517	↗
Nickel	Nickel ores and concentrates (HS 260400[1)])	–0.26	5,855	↑
	Ferronickel (HS 720260[1)])	–0.08	5,206	↑
	Nickel mattes (HS 750110[1)])	0.32	2,861	→
Niobium	Mining output	–0.07	7,837	→
	Ferroniobium output	–0.05	8,169	↗
	Ferroniobium (HS 720293)	–0.02	7,964	→
Palladium	Mining output	–0.18	3,288	→
Phosphate	Natural calcium phosphates and natural aluminium calcium phosphates, natural and phosphatic chalk (unground) (HS 251010)	–0.25	3,400	↘
	Natural calcium phosphates and natural aluminium calcium phosphates, natural and phosphatic chalk (unground) (HS 251020[1)])	–0.34	2,817	→
	Diammonium phosphate (HS 310530)	–0.24	3,309	↘
Platinum	Mining output	–0.07	5,024	↘
	Platinum, unwrought or in powder form (HS 711011[1)])	0.33	2,787	↓
	Waste and scrap of platinum (incl. metal clad with platinum, and other waste and scrap containing platinum or platinum compounds) (HS 711292[1)])	0.44	3,416	→
Rare earths	Mining output	0.00	4,332	↘
	Refinery output	–0.20	8,380	↗
	Cerium compounds (HS 284610[1)])	0.31	2,895	↘

Raw materials	Specification	WCR	HHI	Trend (HHI)
Rhodium	Mining output	–0.10	6,353	↘
	Rhodium, unwrought or in powder form (HS 711031[1)])	0.34	4,636	↑
Ruthenium	Mining output	–0.01	8,588	↗
Silicon	Refinery output	0.03	5,346	↗
	Silicon, containing < 99.99 % by weight of silicon (HS 280469)	0.21	3,841	↘
	Silicon dioxide (HS 281122[1)])	0.25	4,525	→
	Carbides of silicon, whether or not chemically defined (HS 284920)	–0.01	3,393	↘
Silver	Powder of silver (incl. silver plated with gold or platinum) (HS 710610)	–0.35	8,922	↑
	Silver, incl. silver plated with gold or platinum, unwrought (excl. silver in powder form) (HS 710691)	–0.44	9,888	↑
Strontium minerals	Mining output	–0.44	3,028	↗
Tantalum	Mining output	–0.77	1,936	↗
	Unwrought tantalum, incl. bars and rods of tantalum obtained simply by sintering; tantalum powders (HS 810320[1)])	0.35	2,847	→
	Articles of tantalum (n. e. s.) (HS 810390)	0.16	2,615	↓
Tin	Refinery output	–0.08	2,823	→
	Tin ores and concentrates (HS 260900[1)])	–0.73	6,534	↓
	Unwrought tin, not alloyed (HS 800110)	0.10	2,523	→
Titanium	Refinery output	0.05	3,635	↗
	Titanium oxides (HS 282300)	0.25	3,230	↑
	Ferrotitanium and ferrosilicotitanium (HS 720291)	0.12	3,021	→
	Unwrought titanium; titanium powders (HS 810820)	0.49	3,056	↘
Tungsten	Mining output	–0.27	7,328	↑
	Bases, inorganic, and metal oxides, hydroxides and peroxides, n.e.s. (tungsten oxides & hydroxides) (HS 282590[1,2)])	–0.09	5,121	↘
	Tungstates (wolframates) (HS 284180[1)])	0.26	2,997	↓
	Ferrotungsten and ferrosilicotungsten (HS 720280)	–0.43	4,273	↗
	Tungsten powders (HS 810110[1)])	0.43	3,008	↓

Raw materials	Specification	WCR	HHI	Trend (HHI)
Tungsten	Unwrought tungsten, incl. bars and rods of tungsten obtained simply by sintering (HS 810194[1)])	0.20	4,370	↓
Vanadium	Mining output	–0.31	4,785	→
	Vanadium oxides and hydroxides (HS 282530)	–0.26	3,267	↘
Wollastonite	Mining output	–0.17	5,561	↘
Zirconium	Unwrought zirconium; zirconium powders (HS 810920[1)])	0.21	3,632	↘

[1)] Net exports of major supplier countries, some derived from mirror data (global imports from a specific country).
[2)] Net exports based on extended national HS codes.

Germany's dependence on imports

Based on the trade data available for global imports and exports and the net exports calculated from them, we analysed Germany's dependence on imports. This involved comparing Germany's shares of global imports for individual commodity groups with the net exports and thus the risk rating of each commodity group.

Of the 221 commodities analysed, 98 belong to the group with high potential procurement risks (RG 3) based on net exports. Compared to 2018, resources such as beryllium (unwrought), fluorspar, articles of cobalt, lithium oxide and hydroxide, ferronickel, rhodium, titanium (unwrought) and zirconium (unwrought) have been added to this group. Based on the revised data from the previous list, a total of 23 commodities have moved up to RG 3.

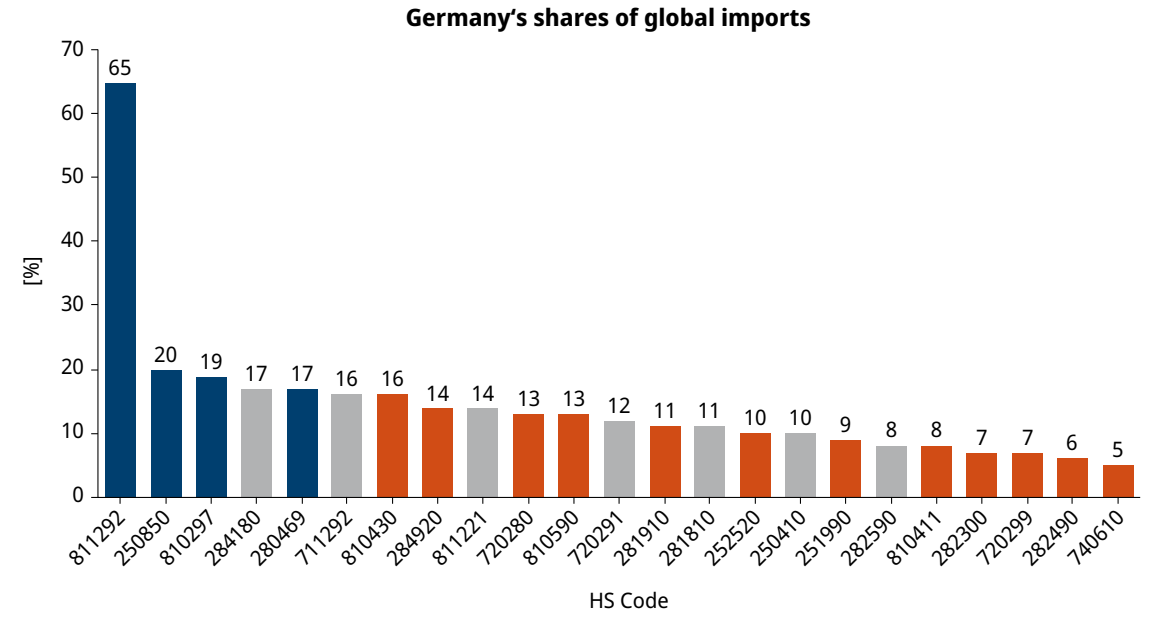
For 61 of the 221 commodity groups analysed, Germany ranked in first, second or third place for pure imports in 2020. Among these intermediate and higher value added products, 23 have a high potential procurement risk, being classed in risk group 3 based on calculated net exports. Germany ranked first in 2020 for four of the commodity groups identified and was thus the world's largest importer (Fig. 5) for gallium (65 %), minerals of the kyanite group (20 %), molybdenum waste/scrap (19.4 %) and silicon (17 %), for instance.

For 12 of the commodity groups in risk group 3, Germany was the second largest importer in 2020, and ranked third for the remaining seven commodity groups (Fig. 5).

German imports accounted for more than 15 % of total imports for seven of the 23 HS commodity groups identified (Fig. 5), for instance, for gallium (65 %), minerals of the kyanite group (20 %), molybdenum waste/scrap (19.4 %), tungstates (17 %), silicon (17 %), platinum waste/scrap (16 %), and magnesium raspings and turnings (16 %).

Compared to 2018, the goods HS 720250, HS 284990, HS 720120, HS 711021, HS 810110, HS 250850, HS 750220, HS 810600, HS 810294, HS 810419, HS 711011, HS 711031, HS 800110, HS 284690, HS 281122 and HS 282580 are no longer included, while HS 250410, HS 282300, HS 282490, HS 711292, HS 740610, HS 810297 and HS 810590 have been added (Fig. 5).

A direct comparison of the 2018 and 2020 data thus shows a decline in the number of commodity groups for which Germany was one of the largest importers. The import dependences identified combined with a high supply concentration in the net exports of these commodity groups could be detrimental for Germany as a manufacturing location. In markets with such a high concentration, disruptions in production or supply are likely to have a particularly strong impact on prices and price volatility.



811292 Gallium	811221 Chromium, unwrought	251990 Magnesia
250850 Kyanite group	720280 Ferrotungsten	282590 Tungsten oxides
810297 Molybdenum waste and scrap	810590 Articles of colbalt (n. e. s.)	810411 Magnesium, unwrought, ≧ 99.8 %
284180 Tungstates	720291 Ferrotitanium	282300 Titanium oxides
280469 Silicon, unwrought	281910 Chromium trioxide	720299 Ferroalloys (n. e. s.)
711292 Platinum waste and scrap	281810 Corundum, artificial	282490 Lead oxides (excl. monoxide)
810430 Magnesium turnings	252520 Mica powder	740610 Copper powders, of non-lamellar structure
284920 Silicon carbide	250410 Flake graphite	

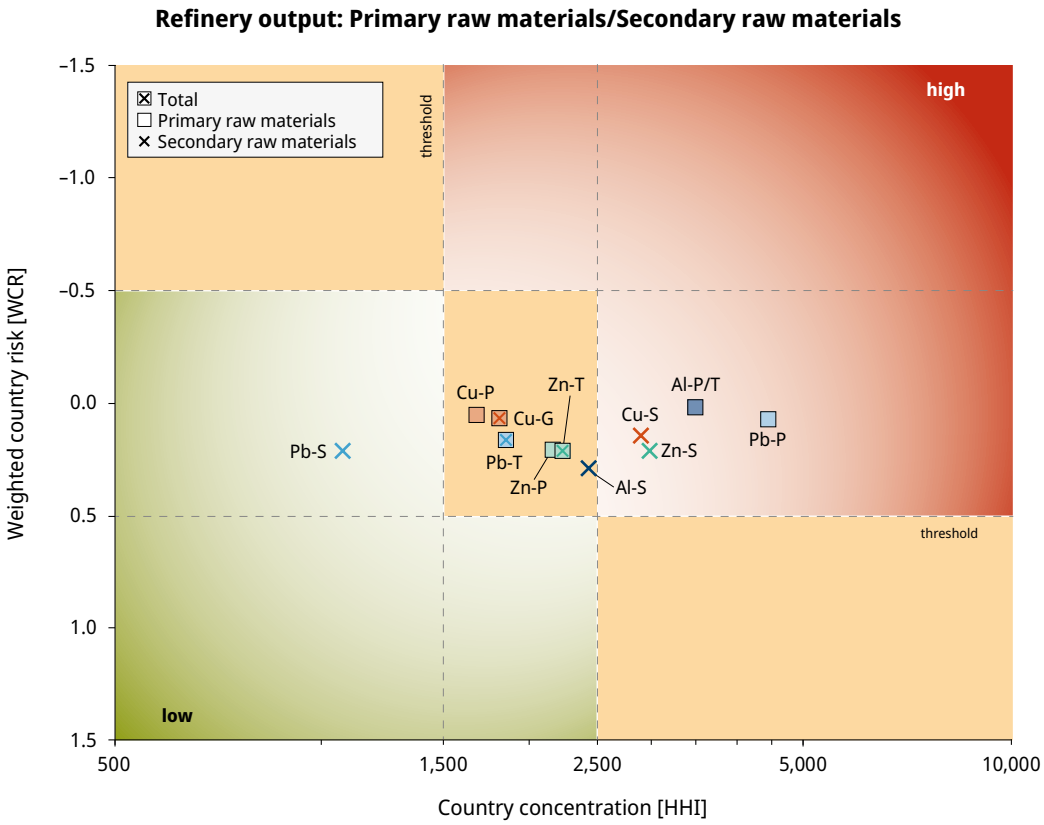
Fig. 5: Germany's shares of global imports for commodity groups for which Germany is one of the three largest importer countries

Differentiating between refinery products from primary and secondary raw materials

Metal resources are limited and their extraction from primary sources has a significant environmental impact. By recycling metals, resources can be reused and the demand for primary raw materials reduced. While, at present, the market for refined products from secondary raw materials is smaller than the primary market, the balance could soon shift towards secondary raw materials if enterprises are legally required to use a certain share of recycled materials in their products. This would increase demand for secondary raw materials, which could in turn boost their share in the production of refined goods. The Critical Raw Materials Act (CRMA) currently under discussion in the EU could be pioneering, marking the start of a new era for secondary raw materials.

To reflect the increasingly important role of secondary raw materials in refinery production, this issue of the Criticality List for the first time differentiates between refined products made from primary and secondary raw materials. Consistent figures that distinguish the two categories have only been available for a few years or decades, and only for the metals aluminium, lead, copper and zinc. Global data availability for metals such as nickel, tin or tungsten is not sufficiently homogeneous and too patchy to permit a differentiation between refined products made from primary and secondary resources.

A comparison of refinery output from primary and secondary raw materials clearly shows that China is the global leader in absolute terms both in the production of primary raw materials and in the recycling of metals. But the figures also



Al-P/T:	Total primary refined aluminium
Al-S:	Secondary refined aluminium
Pb-P:	Primary refined lead
Pb-S:	Secondary refined lead
Cu-P:	Primary refined copper
Cu-S:	Secondary refined copper
Zn-P:	Primary refined zinc
Zn-S:	Secondary refined zinc
Zn-T:	Total refined zinc
Cu-T:	Total refined copper
Pb-T:	Total refined lead

Fig. 6: Country concentration and weighted country risk for refinery output from primary and secondary aluminium, lead, copper and zinc raw materials for 2020

show that European and German producers of refinery products account for a higher than average share of production from secondary raw materials, which would indicate awareness of the environmental benefits and the scarcity of primary raw materials. Fig. 6 shows the weighted country risk (WCR) and country concentration (HHI) for the output of refined aluminium, lead, copper and zinc products from primary and secondary raw materials, and for total output of refined lead, copper and zinc products. The WCR and HHI time series for refinery output from primary and secondary raw materials can be found in the Appendix in Fig. 10. For refined aluminium and lead products from secondary raw materials, the HHI and WCR are lower than for refinery output from primary raw materials. Because of China's position, this is not the same for copper and zinc. Fig. 7 shows that China's market shares in the production of refined aluminium and lead products from primary raw materials (57 % / 63 %) are larger than those

from secondary raw materials (44 % / 29 %). The reverse is true for copper and zinc, where China dominates the recycling market (51 % / 53 %) more than the primary market (39 % / 45 %).

When aluminium is produced from primary raw materials, the aluminium ore bauxite is initially processed into alumina and then into refined aluminium metal. Alloying elements can be added to this. For the production of aluminium from secondary raw materials, there are two types of plants, refiners and remelters. Scrap containing impurities needs pre-treatment; it is pyrometallurgically refined (refiner). An alternative and widely used aluminium recycling method is the direct remelting of aluminium (remelter). Although this is very common and thus the most important recycling route, it is not included in the international data of the World Bureau of Metal Statistics (WBMS). The refinery output from secondary raw materials only reflects production in secondary refiners. Another crucial factor for a proper understanding of aluminium statistics is that the quality of refined aluminium from secondary raw materials is less high than that from primary aluminium, because of the alloying elements. In the DERA Criticality List, the two products are not added to the figures for total refinery output, so these are the same as the figures for primary refinery output.

Worldwide, 65 m t of aluminium were produced from primary materials and 16 m t from secondary materials in 2020. Germany recorded above-average output of aluminium from secondary raw materials of 549,000 t, compared to 539,000 t from primary materials. But China was the largest producer of refined aluminium, accounting for 58 % of global output from primary and 42 % from secondary raw materials. European refinery producers contributed a total of 7 % of output from primary and 17 % from secondary raw materials to global output.

The International Lead and Zinc Study Group (ILZSG) publishes data on the total output of refined lead, whatever the source material used. It includes output from smelting plants and refineries, also the lead content of antimony lead, while excluding molybdenum lead and lead alloys, produced solely by remelting secondary materials without additional treatment. In addition, the statistics list separate data for refined lead and lead alloys produced from secondary raw materials such as scrap, waste and residues. In the analysis presented in the DERA Criticality List, primary refinery output is calculated as the difference between total refinery output and refinery output from secondary raw materials.

In 2020, 64 % of refined lead worldwide was produced from secondary raw materials. With an output of 58 % of lead from secondary raw materials, Germany ranked below the global average. China was the largest producer of refined lead, accounting for 63 % of global output from primary and 29 % from secondary raw materials. European refinery producers contributed a total of 10 % of output from primary and 18 % from secondary raw materials to global output.

The primary sources of refined copper comprise both pyrometallurgical smelting and the electrolytic reduction or refining of mined and smelted materials. Copper produced through primary ore leaching (solvent extraction and electrolysis) is classified as a primary raw material in the Criticality List. In the official statistics of the International Copper Study Group (ICSG), these copper products are listed separately. Copper can be recycled from scrap any number of times without quality losses. Copper from secondary raw materials comprises pyrometallurgically refined anodes and hydrometallurgically produced cathode copper from copper scrap, and remelted new scrap from production residues.

In 2020, 16 % of refined copper worldwide was produced from secondary raw materials. Germany's output was above average, with 39 % of copper from secondary raw materials. China by contrast was the largest producer of refined copper from both primary and secondary raw materials, with 39 % and 51 % respectively. European refinery producers contributed a total of 10 % of output from primary and 22 % from secondary raw materials to global output.

The International Lead and Zinc Study Group (ILZSG) publishes data on the total output of refined zinc, whatever the source material used. It includes zinc both in a marketable form and for direct use as an alloying element by smelting plants and refineries. Possible source materials are ores, concentrates, residues, slag and scrap. Data on refined zinc from secondary raw materials such as scrap, waste and residues, or zinc produced from the condensate of electric arc furnace steel mills as pellets or in another forms, are published separately. In the analysis presented in the DERA Criticality List, primary refinery output is calculated as the difference between total refinery output and refinery output from secondary raw materials. The ILZSG statistics do not include remelted zinc.

In 2020, 12 % of refined zinc worldwide was produced from secondary raw materials. Germany produced 19 % of refined zinc from secondary raw materials. China was the largest producer of refined zinc from both primary and secondary raw materials, with 45 % and 53 % respectively. European refinery producers contributed a total of 15 % of output from primary and 26 % from secondary raw materials.

Major findings

– Supply concentration in the production and processing of mineral resources is high: for 46 % (140 of 305) of all mining products, refinery products and commodities studied for the 2023 DERA Criticality List, the potential procurement risk was high, in terms of both the weighted country risk and supply concentration.

– Many raw materials are predominantly mined, refined and processed in China (Fig. 7, Fig. 11 and Fig. 12).
  China is the leading refiner and processor of ores for all resources studied (28 refinery products) except in the production of ferroniobium, ferronickel and rhenium.
  It is the largest mining country for 21 of the 55 resources studied, and among the three largest mining countries for 12 additional resources.
  China is among the three largest net exporters of 39 of the 98 commodities in risk group 3 and ranks first as the main net exporter for 31 of them. They include a range of commodities based on magnesium, graphite, barium, manganese, corundum, bismuth, molybdenum, antimony, lithium, fluorine, silicon, tungsten, titanium, tantalum, gallium and mica. China's position is particularly evident in the case of magnesium. It is by far the largest exporter of magnesium carbonate, magnesium sulphate and various qualities of unwrought magnesium.
  China's dominance of the raw materials market is also evident when differentiating between refinery products from primary and secondary raw materials. In both categories, China is the global market leader for all four metals analysed (aluminium, lead, copper and zinc).

– While China dominates the market for many raw materials and commodities, often with a market share of more than 75 %, other countries are dominant in some raw materials. Australia, for instance, dominates in the mining of aluminium, iron, garnet, lithium (from hard rock), titanium minerals and zirconium, and Brazil in the production and export of niobium including ferroniobium. Turkey dominates in the extraction of pumice, feldspar and boron minerals and the export of boron products (HS 281000, HS 284019 and HS 284020), and the United States in the mining of beryllium, bentonite and diatomite. DR Congo dominates in the production of tantalum and cobalt, and the export of cobalt concentrates, cobalt matte and intermediate product (HS 260500 and HS 810520). South Africa is the largest mining country for minerals of the kyanite group, and of vermiculite, manganese and chromium, as well as the largest exporter of chromium concentrate and ferrochromium (HS 261000, HS 720241), manganese ore (HS 260200) and andalusite, kyanite and sillimanite (HS 250850). With a market

share of around 70 to 90 %, South Africa is also dominant in the mining of the platinum group elements platinum, rhodium, iridium and ruthenium. Russia dominates the mining of palladium and diamonds, as well as the trade in ferrotungsten (HS 720280), ferrotitanium (HS 72091), a range of pig iron products (HS 720110, HS 720150) and unwrought chromium (HS 811221). Chile is the largest mining country and net exporter of copper, and by far the largest producer of rhenium, a by-product of copper (Fig. 11 and Fig. 12).

– The 2020 data show the impact of the Covid-19 pandemic. For 71 % (39) of the 55 raw materials studied, for instance, mining volumes (mining output) fell in 2020 compared to 2018, as did refinery output for 41 % (12) of the 28 products studied. Net exports of 55 % (54) of the commodities in risk group 3 also declined in 2020.

Fig. 9 and Fig. 10 show long-term trends for a period of up to 60 years.

Changes from the previous study: 2021 DERA Criticality List using 2018 data

For the raw materials at the early stage of the value chain listed below, significant changes in supply concentration and/or the weighted country risk were found for 2020 compared to the 2018 data used in the 2021 DERA Criticality List (DERA 2021).

Mining output

New in risk group 3:

– Ruthenium: first included in the DERA Criticality List in 2023 and therefore new. Data for 2018 show that the mining output of ruthenium was already in risk group 3 in 2018.

– Iridium: first included in the DERA Criticality List in 2023 and therefore new. Data for 2018 show that the mining output of iridium was already in risk group 3 in 2018.

No longer in risk group 3:

– Perlite: revised data show a drop in the mining output of China and Turkey and thus a lower supply concentration already for 2018. The HHI score is below the threshold of 2,500, also for 2018.

Changes between risk groups 1 and 2:

– Pumice: change from RG 2 to RG 1; the HHI fell below the threshold of 1,500. In Turkey, Ethiopia, Germany and Peru, mining output fell significantly.

– Garnet: change from RG 2 to RG 1; the WCR shifted from 0.49 to 0.52 and is therefore above the limit of 0.5. The reason for this is a marked decline in output in South Africa and India, increasing Australia's share (good country risk score).

– Talcum: change from RG 2 to RG 1; the HHI fell below the threshold of 1,500. This also applies for 2018 (revised data). The revised 2018 data already showed China's drop to second place as a talcum mining country (India ranks first), with Brazil replacing the United States in third place. Overall, this resulted in a slight decline in country concentration.

– Iron ore: change from RG 1 to RG 2; the WCR shifted from 0.50 to 0.46 and is thus below the limit of 0.5. This is due to lower mining output by Brazil and Canada in the Covid year 2020. In China and Russia, by contrast, mining outputs rose slightly, increasing their shares somewhat.

– Mica: change from RG 1 to RG 2, due to a significantly higher HHI, exceeding the threshold of 1,500. The WCR also increased considerably. This is because data were revised: the increased risk arises from the higher output figures for China, moving it up from third to first place. This also applies for 2018.

– Zirconium: change from RG 1 to RG 2; the WCR shifted from 0.52 to 0.48 and is thus below the limit of 0.5. A data revision showed that already for 2018 Mozambique, which has a worse country risk score than the United States, increased production, making it the third largest mining country for zirconium and relegating the United States to fourth from previously third place.

Significant changes in supply concentration (HHI) or weighted country risk (WCR):

– Boron minerals: because of data revisions/ new data sources, the country concentration (HHI) and weighted country risk (WCR) increased, also retrospectively for 2018. Turkey's share was probably already significantly higher in 2018, resulting in a considerably higher HHI. The third largest mining country in 2018 and 2020 was Kazakhstan and not Chile, which lowers the WCR. Mining output of boron minerals in Turkey was low in 2020. However, it should not be forgotten that data availability for the mining of boron minerals is very poor, especially for Turkey.

– Kyanite group: a significant output decline in 2020 for all countries compared to 2018. India in particular produced only 25 % of its 2018 volume, moving it down below France and even Peru. And although South Africa increased its shares, it produced less than in 2018.

– Mica: change in risk group (RG) due to a significantly higher HHI, exceeding the threshold of 1,500. The WCR also increased considerably, see above.

– Graphite: China, Mozambique and Brazil probably produced far less in 2020 than in 2018, lowering the country concentration and relegating Mozambique to fifth place.

– Kaolin: compared to 2018, the WCR rose considerably. China strongly increased its output, making it the largest mining country for kaolin in 2020. Revised data show India as the largest mining country in 2018 and not the United States, who produced less in 2020.

– Coking coal: increase in HHI. China's share in global mining output increased.

– Lithium: decline in HHI and increase in WCR. Mining output in Australia significantly declined in 2020 (overproduction in previous years), while it rose in Chile and particularly in China.

– Mercury: significant increase in HHI. Mining output in China, Indonesia and Mexico fell considerably in 2020, with Mexico only the fifth largest producer that year. Overall, however, China's share rose significantly compared to 2018.

– Rare earths: decline in HHI resulting from a considerable increase in mining output in the United States (which rose from fourth place in 2018 to second in 2020). This also led to a decline in China's shares, despite its rise in mining output.

– Strontium minerals: significant increase in WCR because of a considerable rise in mining output in Iran and thus its share in global output.

– Vanadium: because of data revisions/new data sources, particularly for South Africa, the country concentration (HHI) increased, also retrospectively for 2018. China's share rose while South Africa's declined.

– Tungsten: significant increase in HHI. China, by far the largest mining country for tungsten, increased its mining output and consequently its share of global mining output. Countries such as the United Kingdom, Mongolia or North Korea produced less in 2020 than in 2018.

– Wollastonite: increase in HHI. China significantly increased its shares, while India and Mexico's shares fell. This is because of a decline in 2020 mining output in India, Mexico and the United States.

Refinery output

New in risk group 3:

– Ferrochromium: because of a slight increase in supply concentration from an HHI score of 2,477 in 2018 to 2,781 in 2020, ferrochromium moved into the high-concentration range. The weighted country risk, however, decreased slightly. This change resulted from a slightly higher output in China and a significant drop in South Africa, increasing China's share.

Changes between risk groups 1 and 2:

– Ferromanganese: change from RG 1 to RG 2 (this also applies for 2018, because data were revised). At 2,019, the HHI exceeded the threshold of 1,500. A data revision had shown already for 2018 that output in South Africa was lower than assumed two years ago. This considerably decreases South Africa's shares while significantly increasing China's.

– Refined nickel: change from RG 1 to RG 2; the HHI exceeded the threshold of 1,500. Indonesia's output and therefore its share increased significantly (from 13 to 25 %). Output in China also rose, while declining in Japan. Russia replaced Japan in third place.

– Selenium: change from RG 1 to RG 2; the country concentration and weighted country risk increased, moving from the low to moderate risk range. China significantly increased its output and global share. South Korea also increased its output. In Japan and many western countries such as the United States, Finland, Sweden or Canada, output fell in 2020.

Significant changes in supply concentration or weighted country risk:

– Lead (smelter production): following a revision of output figures for China, a significant drop in the HHI and WCR, because of far lower output data for China. This puts China's share of lead output (smelter production) at only 57 % (earlier figures put it at 80 %).

– Pig iron: significant increase in HHI because of an expansion of production in China, increasing its share in global output. India and Japan produced less in 2020.

– Crude steel: increase in HHI because of an expansion of production in China, increasing its share in global output. India and Japan produced less in 2020.

– Germanium: data revision showed that the shares of other producer countries (e. g. Belgium) were higher than previously stated, also for 2018. This reduces China's share and, at 6,000, the HHI was lower than previously stated. Output in both China and Canada significantly rose in 2020 compared to 2018, and consequently also the HHI score.

– Magnesium: lower HHI because of revised data. In contrast to the original data for 2018, there are now output figures for Kazakhstan, South Korea and Ukraine, and higher figures for the United States, resulting in a lower HHI score.

– Ferromanganese: significant increase in country concentration, see above

– Ferromanganese and ferrosilicomanganese: Increase in HHI. The data revision for ferromanganese showed already for 2018 that South Africa's output was lower than assumed two years ago. In addition, China's ferrosilicomanganese output increased significantly compared to 2018, whereas output fell in other countries such as India, Ukraine, Norway and South Africa, resulting in a strong increase in China's share.

– Rare earths: increase in HHI due to a significant rise in output in China.

– Silicon: increase in HHI following a data revision. Compared to the previous list, China's output and thus its share are significantly higher. Output in Norway is also estimated as being higher.

– Titanium: a markedly higher HHI because of a significant increase in China's output and shares, and a decrease in Russia's output and shares.

– Bismuth: significant increase in HHI and decrease in WCR due to a decline in output and output shares in Laos and an increase in China's output shares.

Commodities

Generally speaking, trade data can be subject to high volatility, depending on the commodity group. Among the reasons are, for instance, trade restrictions, disappearance/emergence of supplier countries, relocation of value chains, incorrect or incomplete goods declarations, or revised data. In some cases, new commodity groups are formed and products have to be regrouped. This usually concerns commodity groups that are subject to rapid and strong growth. Compared to the previous Criticality List (DERA-Rohstoffliste 2021) using revised 2018 data, 16 commodities were removed from risk group 3 and 23 new commodities added.

New in risk group 3:

– Beryllium (HS 811212), lead oxides (HS 282490), granulated slag from iron (HS 261800), iron oxides and hydroxides (HS 282110), fluorspar (HS 252922), gold compounds (HS 284330), gold (HS 710812), articles of cobalt (HS 810590), copper alloys (HS 740329), copper powders (HS 7400610), lithium oxides and hydroxides (HS 282520), molybdenum oxides and hydroxides (HS 282570), molybdates (HS 284170), molybdenum waste (HS 810297), ferronickel (HS 720260), platinum waste (HS 711292), rhodium (HS 711031), silver in powder form (HS 710610), unwrought silver (HS 710691), titanium oxides (HS 282300), unwrought titanium (HS 810820), vanadium oxides and hydroxides (HS 282530) and unwrought zirconium (HS 810920). For 14 of these commodity groups, the HHI increased by more than 1,000.

– Gold, articles of cobalt, platinum waste, unwrought silver and molybdates stand out in particular with changes by more than 5,500. A decrease (by no more than 1,200 points) of the HHI was found for only three commodity groups. For all commodity groups listed except one (copper alloys), the WCR also either worsened or changed very little. This is particularly dramatic for articles of cobalt, with the WCR score falling from 0.21 to –1.42.

– Because of an increase in the HHI score by almost 1,000 to 5,107 and a drop in the WCR from 1.15 to -0.04, lithium oxides and hydroxides moved up from RG2 to RG 3.

No longer in risk group 3:

– Antimony ores and concentrates (HS 261710), unwrought antimony (HS 811010), antimony waste (HS 811020), barium sulphate (HS 251110), ferrochromium (HS 720249), powder of diamonds (HS 710510), iron and non-alloy steel (HS 720690), gold (HS 710813), nickel oxides and hydroxides (HS 282540), nickel oxide sinters (HS 750120), nickel alloys (HS 750220), palladium (HS 711021), phosphate (HS 310540), silver ores and concentrates (HS 261610), talcum (HS 252610) and carbides of tungsten (HS 284990).

– The HHI for seven of these commodity groups fell by more than 1,000, in some cases even by between 2,000 and 4,000. While the HHI for the commodity group antimony waste (HS 811020) increased by 3,900, its WCR moved from –0.08 to 0.59 into the non-critical range, which just places this commodity group in risk group 2 despite the

high market concentration. Overall, the WCR improved for 12 of these commodity groups.

The situation is not the same for all globally traded ores and concentrates and for intermediate products of downstream levels of the value chain. Enterprises need to take this into account in procurement and risk management. ESG criteria also play an increasingly important role. This applies in particular to raw materials and intermediate products required, for instance, for the energy transition (wind, solar, battery storage). Vulnerabilities at the start of the value chain often have an impact on downstream areas. Examples of raw materials whose value chains are to a large extent affected by increased procurement risks are listed below:

- Antimony: mining output and commodities: antimony ores and concentrates, antimony oxides, antimony metal and powders, and waste and scrap
- Chromium: mining output and ferrochromium output, and these commodities: chromium ores and concentrates, chromium trioxide, chromium oxides and hydroxides, ferrochromium, ferrosilicochromium, unwrought chromium; chromium powders
- Fluorspar: mining output and these commodities: fluorspar, hydrogen fluoride
- Graphite: mining output and these commodities: natural and artificial graphite
- Cobalt: mining output, refinery output and these commodities: cobalt ores and concentrates, cobalt matte and intermediate products of cobalt metallurgy
- Lithium: mining output and commodities: lithium ores and concentrates, lithium oxide & hydroxide, lithium carbonate
- Magnesium: mining output, refinery output and these commodities: unwrought magnesium, articles of magnesium, magnesium raspings, turnings and granules, sulphates of magnesium, magnesium hydroxide and peroxide, magnesium chloride,
- Molybdenum: mining output, refinery output and these commodities: molybdenum oxides and hydroxides, molybdates and waste or scrap
- Niobium: mining output and ferroniobium output and the commodity ferroniobium
- Platinum group metals: mining output, refinery output and these commodities: unwrought platinum, unwrought palladium and unwrought rhodium
- Rare earths: mining output, refinery output and these commodities: cerium compounds and inorganic or organic rare earth compounds
- Titanium: refinery output and these commodities: unwrought titanium, titanium oxides and ferrotitanium or ferrosilicotitanium
- Tungsten: mining output, refinery output and these commodities: carbides of tungsten, tungsten chemicals, unwrought tungsten, tungsten powders, tungstates, and ferrotungsten or ferrosilicotungsten

4. Conclusion

Commodity markets are usually demand-driven. The main drivers of demand are industrialisation processes and radical technological changes. Developments in recent years have shown the profound changes and challenges that raw materials markets are facing because of the endeavour to decarbonise the economy. The necessary focus on climate-neutral technologies will transform commodity markets for decades to come.

This development also involves risks. Raw materials that were only produced in small volumes just a few years ago are now facing a surge in demand. Added to this, supply concentration in many industrial mineral and metal markets is already very high today. The supply of 46 % of the mining and refinery products and commodities analysed in the 2023 DERA Criticality List is highly concentrated, often in politically unstable countries.

In addition to the risks of high country concentration and the country risk, other factors can affect the price and supply risks for raw materials. Where industry concentration is high, market power can be exercised. Capacity losses or bottlenecks in mines or refineries may lead to supply shortages. The availability of many electronics metals extracted as by-products, such as gallium, germanium or indium, may be limited by the output volumes of the main raw material. Moreover, the environmental and social aspects of mining play an increasingly important role for the processing industry, if only because of the duty to comply with stricter legal requirements such as the Act on Corporate Due Diligence Obligations in Supply Chains (Lieferkettensorgfaltspflichtengesetz, LkSG). This can limit the choice of possible procurement sources, resulting in a higher risk for the commodity supply. Recurring vulnerabilities in the global supply chain were evident, for instance, during the Covid-19 pandemic.

Furthermore, many resources and intermediate products of the first processing level are subject to export restrictions. As a result, only a small part of the total output of a product is exported. Although net exports of many products may be highly diversified in relative terms, this does not take into account that much of the output may not be freely available, resulting in high procurement risks.

In addition to the main drivers of demand already mentioned, new regulations can also have an impact on raw material demand. They include, for instance, the planned ban on ICEs in the EU from 2035, the Inflation Reduction Act (IRA) in the United States, the EU's new Batteries Directive, and its Critical Raw Materials Act (CRMA). In its currently proposed form, particularly the CRMA could have a considerable impact on Europe's raw materials supply, since it sets targets for the expansion of production and processing capacities within the EU.

With the CRMA, the European Commission highlights the importance of recycling for the future supply of raw materials in Europe. For every strategic or critical raw material, there are plans to expand recycling capacities within the EU to at least 15–20 % of European Union annual demand (European Council 2023). Even beyond that, the share of secondary raw materials in refinery production could increase further, as laws may be introduced that require enterprises to use a specified share of secondary raw materials in their products. At present, data availability does not permit a clear differentiation between refined output from primary and secondary raw materials for all resources. It is so far only possible for aluminium, lead, copper and zinc. For other metals, figures for refined output from secondary and primary raw materials are not recorded separately at the national level. But that might change. As more scrap becomes available and the importance of recycling continues to increase, future data availability might improve.

The rising demand for raw materials is an enormous challenge for the recycling industry, and also for the exploration and mining sector. Which sectors will be able to provide the required raw material volumes, and to what extent, depends on the exploration success of mining companies, the development of commodity prices, recovery mechanisms and technologies in recycling, and the willingness to invest in the industries mentioned.

Germany is dependent on imports of raw materials. But most of them are imported not in the form of ores or concentrates, but as processed intermediate or preliminary products. Particularly the steel, the non-ferrous metal, foundry and chemical industries as primary producers also process unprocessed metals and industrial minerals. Most German mechanical and plant engineering firms, the automotive industry and the electronics sector use mainly processed intermediate products. Depending on the different requirements of these sectors, the secure and sustainable sourcing of raw materials has to take into account all aspects of the raw material markets. Vulnerabilities at the start of the value chain often affect downstream areas. Where mining and refinery output are highly concentrated, the trade in ores and concentrates or refinery products is also exposed to the risks associated with this concentration. The potential price and supply risks throughout the remaining value chain are correspondingly high.

This study of concentration on international commodity markets and the criticality of raw materials covers only a limited period of a complex system in flux. Continuous monitoring of raw material markets is essential for enterprises, so they can position themselves accordingly in a rapidly changing market environment. We recommend that enterprises systematically integrate analyses on raw material-related price and supply risks in their supply chain management, and develop suitable alternative strategies especially in areas where these risks could significantly impact commercial success.

References

BGR – Federal Institute for Geosciences and Natural Resources (2023): Fachinformationssystem Rohstoffe. – unpublished; Hanover.

BGR – Federal Institute for Geosciences and Natural Resources (2022): Deutschland – Rohstoffsituation 2021. – 162 pp.; Hanover

Buchholz, P., Huy, D. & Sievers, H. (2012a): DERA-Rohstoffliste 2012 – Angebotskonzentration bei Metallen und Industriemineralen – Potenzielle Preis- und Lieferrisiken. – DERA-Rohstoffinformationen, 10: 45 pp.; Berlin. – URL: http://www.deutsche-rohstoffagentur.de/DE/Gemeinsames/Produkte/Downloads/DERA_Rohstoffinformationen/rohstoffinformationen-10.pdf?
[last updated: 11.10.2014].

Buchholz, P., Liedtke, M. & Gernuks, M. (2012b): Evaluating supply risk patterns and supply and demand trends for mineral raw materials: Assessment of the zinc market. – In: Wellmer, F.-W. & Larsen, R. S. (Eds): Planet Earth in our hands – Theme 5: Non-renewable resource issues – Geoscientific and Societal Challenges. UN International Year of the Planet Earth (IYPE): 157–181; Heidelberg (Springer).

DERA – German Mineral Resources Agency at the Federal Institute for Geosciences and Natural Resources (2014): 2014 DERA Criticality List. – DERA Rohstoffinformationen 24: 112 pp.; Berlin.

DERA – German Mineral Resources Agency at the Federal Institute for Geosciences and Natural Resources (2021): 2021 DERA Criticality List. – DERA Rohstoffinformationen 49: 108 pp.; Berlin.

Eggert, P., Haid, A., Wettig, E., Dahlheimer, M., Kruszona, M. & Wagner, H. (2000): Auswirkungen der weltweiten Konzentration in der Bergbauproduktion auf die Rohstoffversorgung der deutschen Wirtschaft. – Beiträge zur Strukturforschung, vol. 184: 398 pp.; Deutsches Institut für Wirtschaftsforschung, Bundesanstalt für Geowissenschaften und Rohstoffe, Berlin.

European Council (2023): Infographic – An EU critical raw materials act for the future of EU supply chains. – URL: https://www.consilium.europa.eu/de/infographics/critical-raw-materials/
[last updated: 17.07.2023].

Johnson & Matthey (2022): PGM market report May 2022: 60 pp. – URL: https://matthey.com/documents/161599/509428/PGM-market-report-May-2022.pdf/542bcada-f4ac-a673-5f95-ad1bbfca5106?t=1655877358676 [last updated: May 2022].

Rosenau-Tornow, D., Buchholz, P., Riemann, A. & Wagner, M. (2009): Assessing the long-term supply risks for mineral raw materials – a combined evaluation of past and future trends. – Resources Policy 34: 161–175; Amsterdam (Elsevier).

Schmidt, H. & Kruszona, M. (1975): Regionale Verteilung der Weltbergbauproduktion. – Unpublished BGR report: 55 pp.; Hannover.

Schmidt, H. & Kruszona, M. (1982): Regionale Verteilung der Weltbergbauproduktion und der Weltvorräte mineralischer Rohstoffe. – Unpublished BGR report: 125 pp.; Hannover.

U.S. Department of Justice and the Federal Trade Commission (2010): Horizontal Merger Guidelines. – URL: http://www.justice.gov/atr/public/guidelines/hmg-2010.pdf [last updated: 07.02.2019].

Wagner, M., Wagner, H. & Huy, D. (2005): Kurzbericht zur Konzentration in der Weltbergbauproduktion. – Unpublished BGR report: 21 pp.; Hannover.

Wellmer, F.-W., Schmidt, H. & Berner, U. (1996): Untersuchungen über Konzentrierungstrends in der Rohstoffversorgung. – German Federal Ministry for Economic Affairs, BMWi documentation No. 402: 17 pp.; Berlin.

WCO – World Customs Organization (2023): What is the Harmonized System (HS)? – URL: https://www.wcoomd.org/en/topics/nomenclature/overview/what-is-the-harmonized-system.aspx [last updated: 07.06.2023].

Worldbank (2022): Worldwide Governance Indicators. – URL: http://info.worldbank.org/governance/wgi/ [last updated: 25.09.2022].

ZEN Innovations AG (2023): Global Trade Tracker. – Fee-based database. – URL: https://www.globaltradetracker.com/ [last updated: June 2023].

Appendix

Table 2: Summary analysis of all raw materials studied. Only high-risk commodities (risk group 3) are shown.

Aluminium	
Use:	Light metal and alloys, for instance in aircraft and vehicle construction, shipbuilding and car manufacturing; packaging and containers; electrical engineering technology; optics and lighting; alumina/aluminium salts e. g. for health and medical products, refractory products, ceramics, fillers, fireproofing, catalysis, sorbents, abrasives and polishing agents
Output:	
Mining output:	369 m t bauxite
Largest mining countries:	Australia (28.3 %), Guinea (23.8 %), China (18.9 %)
Country concentration:	1,858
Weighted country risk:	0.10
Alumina output:	134 m t
Largest production countries	China (54.4 %), Australia (15.5 %), Brazil (7.6 %)
Country concentration:	3,304
Weighted country risk:	0.11
Refinery output:	65.2 m t cont.
Largest production countries:	China (56.9 %), Russia (5.9 %), India (5.4 %)
Country concentration:	3,367
Weighted country risk:	0.02
Trade:	
Aluminium ores and concentrates (HS 260600)[1]:	143 m t
Largest net exporters:	Guinea (53.2 %), Australia (26.1 %), Indonesia (13 %)
Country concentration:	3,699
Weighted country risk:	–0.13
Corundum, artificial, whether or not chemically defined (HS 281810):	725,000 t
Largest net exporters:	China (85.2 %), Hungary (3.6 %), Ukraine (3.5 %)
Country concentration:	7,301
Weighted country risk:	–0.22
Antimony	
Use:	Fire-retardant additive for plastics, rubber, textiles and paint; antimony-lead alloys for e. g. lead-acid batteries; catalyst in the chemical industry; stabilisers; fining agents (glass industry); pigments

Output:	
Mining output:	116,000 t cont.
Largest mining countries:	China (55.7 %), Tajikistan (19.5 %), Russia (14.5 %)
Country concentration:	3,717
Weighted country risk:	–0.46
Trade:	
Antimony oxides (HS 282580):	53,900 t
Largest net exporters:	China (67.9 %), Belgium (17.1 %), France (9.3 %)
Country concentration:	5,012
Weighted country risk:	0.10
Baryte	
Use:	Drilling fluids, filler (for paper, paints etc.), production of barium chemicals, additive in glass production; additive in heavy concrete, contrast medium for X-rays
Output:	
Mining output:	6.93 m t
Largest mining countries:	China (40.4 %), India (21.6 %), Morocco (7.2 %)
Country concentration:	2,260
Weighted country risk:	–0.27
Trade:	
Natural barium carbonate (witherite), whether or not calcined (excl. barium oxide) (HS 251120)[1]:	2,350 t
Largest net exporters:	USA (60.6 %), China (25.7 %), Morocco (11.5 %)
Country concentration:	4,468
Weighted country risk:	0.49
Sulphates of barium (HS 283327)[1]:	125,000 t
Largest net exporters:	China (88.9 %), Germany (9.7 %), Netherlands (0.8 %)
Country concentration:	8,002
Weighted country risk:	–0.09
Bentonite	
Use:	Drilling fluids; cat litter; foundry sand; pelleting of iron ores; sealant in the construction industry; water purification; oil binder; adsorbent; clarification and decolourisation of oils; beer stabiliser; fire extinguishers; polishing agents; fillers; pharmaceuticals; cosmetics
Output:	
Mining output:	19.0 m t

Largest mining countries:	USA (22.4 %), India (18.4 %), China (13.2 %)
Country concentration:	1,220
Weighted country risk:	0.09
Beryllium	
Use:	Beryllium-copper alloys, beryllium oxide ceramics and beryllium metal e. g. for electrical equipment (connectors, contacts, connections, switches, relays etc.); bearings; housings; wires; disc brakes; non-magnetic steels; drill bits; windows for X-ray tubes
Output:	
Mining output:	6,320 t of beryl
Largest mining countries:	USA (65.6 %), China (27.7 %), Uganda (2.9 %)
Country concentration:	5,086
Weighted country risk:	0.53
Trade:	
Unwrought beryllium; beryllium powders (HS 811212)[1]:	33.5 t
Largest net exporters:	Kazakhstan (48.2 %), France (23.8 %), USA (15.7 %)
Country concentration:	3,285
Weighted country risk:	0.40
Bismuth	
Use:	Metallurgy (fusible alloys); solders; pharmaceuticals; cosmetics; pigment; optical glasses
Output:	
Refinery output:	18,900 t cont.
Largest production countries:	China (84.6 %), Laos (5.2 %), Republic of Korea (5.1 %)
Country concentration:	7,221
Weighted country risk:	–0.18
Trade:	
Bismuth and articles thereof, n. e. s.; bismuth waste and scrap (excl. ash and residues containing bismuth) (HS 810600)[1]:	7,230 t
Largest net exporters:	China (75.8 %), Republic of Korea (10 %), Kazakhstan (6.2 %)
Country concentration:	5,899
Weighted country risk:	–0.15
Boron minerals	
Use:	Glass; glass wool; glass fibre fabrics; ceramics; enamel; fertilisers; detergents and cleaning agents (bleaching agents); metallurgy (e. g. fluxes; fining agents; ferroboron); flame retardants; cosmetics

Output:	
Mining output:	5.33 m t
Largest mining countries:	Turkey (52.8 %), USA (15.6 %), Kazakhstan (9.4 %)
Country concentration:	3,235
Weighted country risk:	–0.16
Trade:	
Oxides of boron; boric acids (HS 281000)[1]:	706,000 t
Largest net exporters:	Turkey (38.6 %), USA (31 %), Chile (13.8 %)
Country concentration:	2,744
Weighted country risk:	0.17
Disodium tetraborate (refined borax) (excl. anhydrous) (HS 284019)[1]:	1.25 m t
Largest net exporters:	Turkey (65.3 %), USA (30.2 %), Netherlands (3.2 %)
Country concentration:	5,186
Weighted country risk:	0.04
Borates (excl. disodium tetraborate [refined borax]) (HS 284020)[1]:	64,800 t
Largest net exporters:	Turkey (50.9 %), USA (21 %), Peru (10.3 %)
Country concentration:	3,255
Weighted country risk:	–0.04
Cadmium	
Use:	Batteries; alloys; plastics stabiliser; pigments; thin-film solar cells; anti-corrosion agents (aerospace industry); in the European Union, the use of cadmium in batteries, jewellery, alloys for soldering and in plastics/PVC is banned or severely restricted.
Output:	
Refinery output (by-products):	26,000 t cont.
Largest production countries:	China (39.8 %), Republic of Korea (15.7 %), Japan (7.5 %)
Country concentration:	2,027
Weighted country risk:	0.30
Chromium	
Use:	Stainless steels; alloys; protective and decorative coatings; superrefractory products; chemicals; tanning; pigments; catalysts
Output:	
Mining output:	30.4 m t of chromium ore
Largest mining countries:	South Africa (43.5 %), Kazakhstan (20.8 %), Turkey (10.2 %)

Country concentration:	2,559
Weighted country risk:	–0.11
Ferrochromium output:	12.6 m t
Largest production countries:	China (45.2 %), South Africa (21.4 %), Kazakhstan (14.6 %)
Country concentration:	2,781
Weighted country risk:	–0.11
Trade:	
Chromium ores and concentrates (HS 261000):	16.2 m t
Largest net exporters:	South Africa (82.8 %), Turkey (4.8 %), Zimbabwe (4.7 %)
Country concentration:	6,916
Weighted country risk:	–0.06
Chromium trioxide (HS 281910)[1]:	34,400 t
Largest net exporters:	Turkey (32.1 %), USA (31.5 %), Kazakhstan (25.4 %)
Country concentration:	2,705
Weighted country risk:	0.09
Chromium oxides and hydroxides (excl. chromium trioxide) (HS 281990)[1]:	37,200 t
Largest net exporters:	Kazakhstan (61.1 %), Germany (13.5 %), Russia (11.2 %)
Country concentration:	4,134
Weighted country risk:	–0.08
Ferrochromium, containing by weight > 4 % of carbon (HS 720241):	6.25 m t
Largest net exporters:	South Africa (50.8 %), Kazakhstan (23.9 %), India (10.6 %)
Country concentration:	3,315
Weighted country risk:	–0.03
Ferrosilicochromium (HS 720250):	43,200 t
Largest net exporters:	Kazakhstan (58.4 %), Poland (11.8 %), Brazil (9.5 %)
Country concentration:	3,742
Weighted country risk:	–0.18
Unwrought chromium; chromium powders (HS 811221):	30,200 t
Largest net exporters:	Russia (58.1 %), France (21.9 %), United Kingdom (15.8 %)
Country concentration:	4,118
Weighted country risk:	0.04

Cobalt	
Use:	Batteries; superalloys; carbides; catalysts; magnets; pigments; special chemicals (e. g. cobalt carboxylates for tyre manufacture); high-speed steels, surface coating, magnetic tapes
Output:	
Mining output:	126,000 t cont.
Largest mining countries:	DR Congo (68.8 %), Australia (4.5 %), Russia (4 %)
Country concentration:	4,829
Weighted country risk:	–1.07
Refinery output:	126,000 t cont.
Largest production countries:	China (63.6 %), Finland (12 %), Belgium (5.2 %)
Country concentration:	4,277
Weighted country risk:	0.29
Trade:	
Cobalt ores and concentrates (HS 260500)[1]:	60,500 t
Largest net exporters:	DR Congo (98.9 %), Zambia (0.3 %), Ireland (0.3 %)
Country concentration:	9,787
Weighted country risk:	–1.57
Cobalt oxides and hydroxides; commercial cobalt oxides (HS 282200)[1]:	41,900 t
Largest net exporters:	USA (45.4 %), DR Congo (23.3 %), Finland (11.3 %)
Country concentration:	2.891
Weighted country risk:	0,36
Cobalt mattes and other intermediate products of cobalt metallurgy; unwrought cobalt; cobalt powders (HS 810520)[1]:	338,000 t
Largest net exporters:	DR Congo (89.1 %), Russia (2.4 %), Canada (2.1 %)
Country concentration:	7,956
Weighted country risk:	–1.39
Articles of cobalt (n. e. s.) (HS 810590)[1]:	34,100 t
Largest net exporters:	DR Congo (92.9 %), USA (3.8 %), Zambia (1 %)
Country concentration:	8,652
Weighted country risk:	–1.42

Coking coal	
Use:	Reducing agent and energy source in iron and steel production
Output:	
Mining output:	1.01 bn t
Largest mining countries:	China (55.4 %), Australia (18.1 %), Russia (8.9 %)
Country concentration:	3,527
Weighted country risk:	0.14
Copper	
Use:	Copper metal and alloys (brass; bronze; nickel silver) for pipes, cables, wires, lines, sheets etc. in construction; transportation; electrical engineering technology; machine construction; coins
Output:	
Mining output:	20.7 m t cont.
Largest mining countries:	Chile (27.7 %), Peru (10.4 %), China (8.3 %)
Country concentration:	1,144
Weighted country risk:	0.13
Refinery output:	24.6 m t cont.
Largest production countries:	China (40.8 %), Chile (9.5 %), Japan (6.4 %)
Country concentration:	1,899
Weighted country risk:	0.08
Trade:	
Copper, unrefined; copper anodes for electrolytic refining (HS 740200)[1]:	1.44 m t
Largest net exporters:	Zambia (45 %), Chile (20.6 %), Bulgaria (7.7 %)
Country concentration:	2,618
Weighted country risk:	–0.12
Copper, refined, in the form of wire-bars (HS 740312)[1]:	48,700 t
Largest net exporters:	Nigeria (84.8 %), India (3.4 %), Netherlands (2.9 %)
Country concentration:	7,226
Weighted country risk:	–0.86
Copper, refined, unwrought (excl. copper in the form of billets, wire-bars, cathodes and sections of cathodes) (HS 740319):	563,000 t
Largest net exporters:	DR Congo (49.5 %), Kazakhstan (11.2 %), Pakistan (10.7 %)
Country concentration:	2,792
Weighted country risk:	–0.72

Copper alloys unwrought (excl. copper-zinc base alloys [brass], copper-tin base alloys [bronze] and copper master alloys of heading 7405) (HS 740329)[1]:	149,000 t
Largest net exporters:	Malaysia (50 %), Thailand (9.2 %), Japan (5.6 %)
Country concentration:	2,724
Weighted country risk:	0.35
Copper powders, of non-lamellar structure (excl. grains of copper) (HS 740610):	110,000 t
Largest net exporters:	Malaysia (71.6 %), Hong Kong (6.7 %), Russia (3.9 %)
Country concentration:	5,219
Weighted country risk:	0.47
Copper powders, of lamellar structure, and flakes of copper (excl. grains of copper and spangles of heading 8308) (HS 740620):	167,000 t
Largest net exporters:	Malaysia (94.2 %), Germany (1.8 %), Republic of Korea (1.5 %)
Country concentration:	8,883
Weighted country risk:	0.45
Diamonds	
Use:	Gemstone; drilling, cutting and grinding tools; abrasives and polishing agents; electrical engineering technology (electronic circuits, semiconductors, supraconductors)
Output:	
Mining output:	109 m carat
Largest mining countries:	Russia (28.7 %), Botswana (15.6 %), Canada (13.3 %)
Country concentration:	1,607
Weighted country risk:	–0.04
Trade:	
Industrial diamonds unworked or simply sawn, cleaved or bruted (HS 710221)[1]:	38.8 bn carat
Largest net exporters:	Angola (99.3 %), Central African Republic (0.6 %), Russia (0 %)
Country concentration:	9,865
Weighted country risk:	–0.88

Non-industrial diamonds unworked or simply sawn, cleaved or bruted (excl. industrial diamonds) (HS 710231)[1]:	711 m carat
Largest net exporters:	Lesotho (89.9 %), Russia (4 %), Canada (2.1 %)
Country concentration:	8,112
Weighted country risk:	–0.35
Diatomite	
Use:	Filter medium; filler (for silicone rubber, plastics, paper, paints, pharmaceuticals; cosmetics etc.); carrier material (for catalysts, insecticides, explosives, disinfectants etc.); abrasives and polishing agents; insulants (insulation and construction materials); sorbents (gas purification, cat litter, drying agents); powder material
Output:	
Mining output:	2.25 m t
Largest mining countries:	USA (36.6 %), Mexico (6.4 %), China (6.2 %)
Country concentration:	1,601
Weighted country risk:	0.50
Feldspar	
Use:	Ceramics; glass; glazing; enamels; abrasives; filler (varnishes, paints, adhesives, rubber, plastics, soaps and cleaners); fluxes; cosmetics
Output:	
Mining output:	29.3 m t
Largest mining countries:	Turkey (34.3 %), India (14.7 %), China (8.5 %)
Country concentration:	1,613
Weighted country risk:	–0.18
Trade:	
Feldspar (HS 252910):	8.42 m t
Largest net exporters:	Turkey (66.3 %), Thailand (8.8 %), India (7.9 %)
Country concentration:	4,579
Weighted country risk:	–0.35
Fluorspar	
Use:	Hydrogen fluoride (hydrofluoric acid); fluorochemicals e. g. for coatings, anti-adhesive coatings, proofing agents, breathable membranes, implants, coolants, cleaners, wood preservatives, etchants etc.; synthetic cryolite; aluminium fluoride (for aluminium production); fluxes (steel and cast iron production); fluxes and opacifiers (production of frits, enamels, glazing); optical glasses

Output:	
Mining output:	8.93 m t
Largest mining countries:	China (60.5 %), Mexico (17.6 %), Mongolia (7.6 %)
Country concentration:	4,055
Weighted country risk:	–0.24
Trade:	
Fluorspar containing by weight ≦ 97 % calcium fluoride (HS 252921)[1]:	1.26 m t
Largest net exporters:	Mongolia (53.5 %), Mexico (18.9 %), South Africa (9.5 %)
Country concentration:	3,389
Weighted country risk:	–0.10
Fluorspar containing by weight > 97 % calcium fluoride (HS 252922)[1]:	1.12 m t
Largest net exporters:	Mexico (49 %), South Africa (21.7 %), Viet Nam (11.5 %)
Country concentration:	3,092
Weighted country risk:	–0.09
Hydrogen fluoride (hydrofluoric acid) (HS 281111):	371,000 t
Largest net exporters:	China (63.1 %), Mexico (24.7 %), Germany (11.6 %)
Country concentration:	4,728
Weighted country risk:	–0.12
Gallium	
Use:	Semiconductors for integrated circuits (e. g. smartphones) and optoelectronic devices (LEDs, laser diodes, photodiodes, solar cells etc.); fusible alloys; mercury substitute for thermometer liquids
Output:	
Primary gallium output:	327 t cont.
Largest production countries:	China (96.9 %), Russia (1.5 %), Japan (0.9 %)
Country concentration:	9,401
Weighted country risk:	–0.25
Production capacity primary gallium:	768 t cont.
Largest production countries:	China (84.6 %), Germany (3.9 %), Kazakhstan (3.3 %)
Country concentration:	7,204
Weighted country risk:	–0.15

Trade:	
Unwrought hafnium, niobium (columbium), rhenium, gallium, indium, vanadium and germanium; powders and waste and scrap of these metals (excl. ash and residues) (gallium) (HS 811292)[1,2]:	64.0 t
Largest net exporters:	China (56.2 %), Russia (18.8 %), Slovakia (15.6 %)
Country concentration:	3,848
Weighted country risk:	–0.08
Garnet	
Use:	Blasting agents for (sand) blasting ; water filtration; additive for water jet cutting; abrasives (sandpaper, polishing pastes and powders)
Output:	
Mining output:	1.10 m t
Largest mining countries:	Australia (32.7 %), China (28.2 %), South Africa (12.7 %)
Country concentration:	2,247
Weighted country risk:	0.52
Germanium	
Use:	Optical fibres (e. g. fibre-optic cables); infrared technology (e. g. night-vision devices for military applications); catalyst for the production of plastics; electronics (semiconductors); solar cells
Output:	
Refinery output (by-products):	174 t cont.
Largest production countries:	China (78.7 %), Canada (8.6 %), USA (3.4 %)
Country concentration:	6,297
Weighted country risk:	–0.08
Gold	
Use:	Jewellery; electrical engineering technology (contacts); dental technology; coins and medals; investment; surface gold plating; optical applications (coatings, mirrors etc.)
Output:	
Mining output:	3,200 t cont.
Largest mining countries:	China (11.4 %), Australia (10.2 %), Russia (9.6 %)
Country concentration:	520
Weighted country risk:	–0.04

Trade:	
Gold compounds, inorganic or organic, whether or not chemically defined (HS 284330)[1]:	2,270 t
Largest net exporters:	Spain (60.8 %), Saudi Arabia (19 %), Peru (13.1 %)
Country concentration:	4,247
Weighted country risk:	0.45
Gold (incl. gold plated with platinum), unwrought, for non-monetary purposes (excl. gold in powder form) (HS 710812):	279,000 t
Largest net exporters:	Mexico (78.7 %), Egypt (20 %), Qatar (0.2 %)
Country concentration:	6,596
Weighted country risk:	–0.51
Graphite	
Use:	Refractory products and crucibles; foundry and steel manufacture (e. g. nodular graphite); conductive mouldings (e. g. carbon brushes); batteries; brake linings; lubricants; powder metallurgy; pencil leads; welding electrodes; additives and dispersants
Output:	
Mining output:	985,000 t
Largest mining countries:	China (77.4 %), Brazil (6.8 %), Madagascar (4.9 %)
Country concentration:	6,074
Weighted country risk:	–0.29
Trade:	
Natural graphite in powder or in flakes (HS 250410)[1]:	259,000 t
Largest net exporters:	China (59.5 %), Madagascar (12.6 %), Mozambique (11.5 %)
Country concentration:	3,896
Weighted country risk:	–0.41
Natural graphite (excl. in powder or in flakes) (HS 250490)[1]:	77,600 t
Largest net exporters:	China (92.5 %), Tanzania (3.2 %), Germany (2.2 %)
Country concentration:	8,580
Weighted country risk:	–0.24

Artificial graphite (excl. retort graphite, retort carbon and goods of artificial graphite, incl. refractory materials based on artificial graphite) (HS 380110)[1]:	669,000 t
Largest net exporters:	China (87.6 %), Russia (4.6 %), Switzerland (1.8 %)
Country concentration:	7,700
Weighted country risk:	–0.17
Gypsum/anhydrite	
Use:	Construction elements; binding agent for dry, interior and underground construction; cement set retarder; process engineering additives; special plasters; fillers and carrier materials; fertilisers; chemical feedstock
Output:	
Mining output:	161 m t
Largest mining countries:	USA (13.4 %), Iran (9.4 %), Spain (8.3 %)
Country concentration:	601
Weighted country risk:	0.11
Halite	
Use:	Edible salt; industrial salt (chlorine-alkali electrolysis, caustic soda production); commercial salt (e. g. dishwasher salt, pharmaceuticals and cosmetics, feed); de-icing salt
Output:	
Mining output:	276 m t
Largest mining countries:	China (22,8 %), USA (14,7 %), India (9,6 %)
Country concentration:	963
Weighted country risk:	0.29
Indium	
Use:	Indium-tin-oxide (in liquid crystal (LCDs) and flat-panel displays); low-temperature alloys; solders (e. g. lead-free solders); semiconductors (e. g. in LEDs, laser diodes); thin-film solar cells
Output:	
Refinery output (by-products):	813 t cont.
Largest production countries:	China (61.5 %), Republic of Korea (12.3 %), Japan (8.6 %)
Country concentration:	4,100
Weighted country risk:	0.25

Iridium	
Use:	Hardening of platinum (platinum alloys e. g. for pacemakers, medical probes); platinum-iridium alloys in jewellery, pen points, surgical markers and pins, electrical contacts and ignition tips; anode catalysts for PEM electrolysers; production of synthetic sapphires and other crystals (for LED and OLED lights, flat-panel displays, mobile electronic devices), other uses
Output:	
Mining output:	7.27 t cont.
Largest mining countries:	South Africa (85.1 %), Zimbabwe (11.5 %), Russia (3.4 %)
Country concentration:	7,380
Weighted country risk:	–0.11
Iron	
Use:	Steel, cast iron, pig iron, alloys for steel and concrete structures, machine and plant con-struction, shipbuilding, vehicle con-struction and tool manufacturing; chemicals; pharmaceuticals; fertilisers; pigments
Output:	
Mining output:	1.53 bn t cont.
Largest mining countries:	Australia (37 %), Brazil (16.2 %), China (14.8 %)
Country concentration:	1,973
Weighted country risk:	0.46
Crude steel output:	1.88 bn t cont.
Largest production countries:	China (56.6 %), India (5.3 %), Japan (4.4 %)
Country concentration:	3,314
Weighted country risk:	0.00
Pig iron output:	1.32 bn t cont.
Largest production countries:	China (67.3 %), India (5.1 %), Japan (4.7 %)
Country concentration:	4,624
Weighted country risk:	–0.04
Trade:	
Roasted iron pyrites (HS 260120):	675,000 t
Largest net exporters:	Brazil (63.9 %), Iran (18.8 %), Australia (7.5 %)
Country concentration:	4,528
Weighted country risk:	–0.24
Granulated slag (slag sand) from the manufacture of iron or steel (HS 261800):	67.5 m t
Largest net exporters:	Malaysia (66.8 %), Japan (14 %), India (5.6 %)

Country concentration:	4,710
Weighted country risk:	0.49
Iron oxides and hydroxides (HS 282110):	895,000 t
Largest net exporters:	Mauritania (60.2 %), China (15 %), Sweden (5 %)
Country concentration:	3,916
Weighted country risk:	–0.29
Non-alloy pig iron in pigs, blocks or other primary forms, contain-ing, by weight, ≦ 0.5 % of phospho-rus (HS 720110):	12.6 m t
Largest net exporters:	Russia (31.4 %), Brazil (29.8 %), Ukraine (24.7 %)
Country concentration:	2,525
Weighted country risk:	–0.34
Non-alloy pig iron in pigs, blocks or other primary forms, containing, by weight, > 0.5 % of phospho-rus (HS 720120)[1]:	26,500 t
Largest net exporters:	Kazakhstan (75.3 %), Germany (12.4 %), USA (8.9 %)
Country concentration:	5,910
Weighted country risk:	0.02
Alloy pig iron and spiegel-eisen, in pigs, blocks or other primary forms (HS 720150):	557,000 t
Largest net exporters:	Russia (41.4 %), Indonesia (33.4 %), USA (10 %)
Country concentration:	2,988
Weighted country risk:	–0.10
Ferroalloys (excl. ferroman-ganese, ferrosilicon, ferro-silicomanganese, ferrochro-mium, ferrosilicochromium, ferronickel, ferromolybde-num, ferrotungsten, ferrosil-icotungsten, ferrotitanium, ferrosilicotitanium, ferrova-nadium and ferroniobium) (HS 720299):	196,000 t
Largest net exporters:	China (39.2 %), France (26.4 %), Brazil (16.9 %)
Country concentration:	2,622
Weighted country risk:	0.30

Spongy ferrous products, ob-tained from molten pig iron by atomisation, iron of a purity of ≧ 99.94 % (in lumps, pellets or similar forms) (HS 720390)[1]:	972,000 t
Largest net exporters:	USA (53.4 %), Iran (27.9 %), Russia (12.9 %)
Country concentration:	3,807
Weighted country risk:	0.11
Granules, of pig iron, spiegeleisen, iron or steel (excl. granules of ferroalloys, turnings and filings of iron or steel) (HS 720510)[1]:	571,000 t
Largest net exporters:	India (63.8 %), China (10.8 %), Germany (3.9 %)
Country concentration:	4,248
Weighted country risk:	0.02
Ingots, of iron and non-alloy steel (excl. remelted scrap ingots, continuous cast products, iron of heading 7203) (HS 720610):	2.27 m t
Largest net exporters:	Iran (97.7 %), Italy (0.7 %), Poland (0.6 %)
Country concentration:	9,554
Weighted country risk:	–1.22
Kaolin	
Use:	Paper coatings; ceramics; china; glass fibre and mineral wool; fillers and extenders; adsorbents; pigments; aluminium synthesis; production of special cements
Output:	
Mining output:	40.2 m t
Largest mining countries:	China (21 %), India (20.8 %), USA (11.4 %)
Country concentration:	1,142
Weighted country risk:	–0.03
Kyanite group	
Use:	Superrefractory products; ceramics; high-alumina cement
Output:	
Mining output:	358,000 t
Largest mining countries:	South Africa (47.5 %), USA (18.8 %), France (18.2 %)
Country concentration:	3,068
Weighted country risk:	0.39

Trade:	
Andalusite, kyanite and sillimanite (HS 250850):	254,000 t
Largest net exporters:	South Africa (49.6 %), France (16.7 %), USA (14.4 %)
Country concentration:	3,089
Weighted country risk:	0.35
Lead	
Use:	Batteries; alloys; electrical engineering technology, radiology
Output:	
Mining output:	4.51 m t cont.
Largest mining countries:	China (43.7 %), Australia (11 %), USA (6.8 %)
Country concentration:	2,195
Weighted country risk:	0.01
Lead (smelter production) output:	4.84 m t cont.
Largest production countries:	China (57.2 %), Republic of Korea (8.9 %), Iran (4.4 %)
Country concentration:	3,459
Weighted country risk:	0.06
Refined lead output:	12.0 m t cont.
Largest production countries:	China (41.4 %), USA (9.6 %), India (6.8 %)
Country concentration:	1,943
Weighted country risk:	0.19
Trade:	
Lead oxides (excl. monoxide [litharge, massicot]) (HS 282490)[1]:	45,900 t
Largest net exporters:	India (57.2 %), Spain (12 %), Italy (6.4 %)
Country concentration:	3,534
Weighted country risk:	0.21
Lithium	
Use:	Ceramics and glass; batteries; lubricants; air treatment; continuous casting; primary aluminium production; pharmaceuticals; plastics
Output:	
Mining output:	82,200 t cont.
Largest mining countries:	Australia (48.3 %), Chile (26.2 %), China (16.2 %)
Country concentration:	3,331
Weighted country risk:	0.87

Trade:	
Lithium oxide and hydroxide (HS 282520):	80,500 t
Largest net exporters:	China (69.6 %), Chile (11.6 %), Russia (9.4 %)
Country concentration:	5,107
Weighted country risk:	–0.04
Magnesite	
Use:	Refractory products; absorbents, filters; animal feed; fertilisers; magnesite screed; fluxes; chemical industry; insulant and filler; glass; ceramics; sugar refining
Output:	
Mining output:	28.3 m t
Largest mining countries:	China (67 %), Brazil (6 %), Turkey (5.5 %)
Country concentration:	4,616
Weighted country risk:	–0.10
Trade:	
Natural magnesium carbonate (magnesite) (HS 251910):	833,000 t
Largest net exporters:	China (60.4 %), Finland (18.6 %), Spain (6.6 %)
Country concentration:	4,092
Weighted country risk:	0.16
Fused magnesia; dead-burned (sintered) magnesia, whether or not containing small quantities of other oxides added before sintering; other magnesium oxide (HS 251990):	3.48 m t
Largest net exporters:	China (72.9 %), Slovakia (6.8 %), Turkey (6.2 %)
Country concentration:	5,441
Weighted country risk:	–0.16
Magnesium	
Use:	Magnesium metal (die casting) and alloys e. g. for aircraft, vehicle and machine construction; desulphurisation of steel; reducing agent in metallurgy; nodular graphite casting; chemical industry; fertiliser
Output:	
Refinery output:	986,000 t cont.
Largest production countries:	China (86.8 %), USA (3.4 %), Russia (3.2 %)
Country concentration:	7,568
Weighted country risk:	–0.23

Trade:	
Sulphates of magnesium (HS 283321):	1.36 m t
Largest net exporters:	China (77.1 %), Germany (17.9 %), India (4.7 %)
Country concentration:	6,283
Weighted country risk:	0.04
Unwrought magnesium, con-taining ≧ 99.8 % by weight of magnesium (HS 810411):	207,000 t
Largest net exporters:	China (98.5 %), Turkey (1.3 %), Kazakhstan (0.2 %)
Country concentration:	9,704
Weighted country risk:	–0.27
Unwrought magnesium, containing < 99.8 % by weight of magnesium (HS 810419):	118,000 t
Largest net exporters:	China (90.4 %), Czechia (5.2 %), Hungary (3.5 %)
Country concentration:	8,219
Weighted country risk:	–0.17
Magnesium raspings, turn-ings and granules; magne-sium powders (HS 810430)[1]:	72,600 t
Largest net exporters:	China (97.6 %), Russia (1.7 %), Bulgaria (0.4 %)
Country concentration:	9,538
Weighted country risk:	–0.27
Articles of magnesium (n. e. s.) (HS 810490)[1]:	24,900 t
Largest net exporters:	China (85.8 %), Serbia (5.2 %), Bulgaria (2.5 %)
Country concentration:	7,399
Weighted country risk:	–0.16
Manganese	
Use:	Steel alloying; manganese alloys for deoxidising in the iron and steel industries; resistance alloys; batteries; ceramic magnetic materials; pigments; oxidising agent; chemicals; zinc electrolysis; fertilisers
Output:	
Mining output:	18.9 m t cont.
Largest mining countries:	South Africa (34.4 %), Australia (17.7 %), Gabon (17.6 %)
Country concentration:	1,913
Weighted country risk:	0.08

Ferromanganese output:	4.41 m t
Largest production countries:	China (39.6 %), India (14.7 %), Japan (8.8 %)
Country concentration:	2,019
Weighted country risk:	0.17
Ferromanganese + ferro-silicomanganese output:	21.7 m t
Largest production countries:	China (67.8 %), India (11.1 %), Ukraine (3.3 %)
Country concentration:	4,755
Weighted country risk:	–0.10
Trade:	
Manganese ores and concentrates, incl. ferruginous manganese ores and concentrates, with a manganese content of ≧ 20 %, calculated on the dry weight (HS 260200)[1]:	41.4 m t
Largest net exporters:	South Africa (47 %), Australia (16.9 %), Gabon (16.6 %)
Country concentration:	2,884
Weighted country risk:	0.12
Manganese and articles thereof, n. e. s.; manganese waste and scrap (excl. ash and residues containing manganese) (HS 811100):	405,000 t
Largest net exporters:	China (87.1 %), South Africa (6.2 %), Senegal (4.9 %)
Country concentration:	7,646
Weighted country risk:	–0.21
Mercury	
Use:	Mercury switches; gas discharge lamps (fluorescent lamps, cold cathodes etc.); amal-gams (e. g. dental filling materials); electrolysis; gold panning; mercury thermometers
Output:	
Mining output:	2,330 t cont.
Largest mining countries:	China (85.6 %), Indonesia (5.3 %), Tajikistan (3.9 %)
Country concentration:	7,385
Weighted country risk:	–0.30
Mica	
Use:	Fillers (spackling, grouting, paper, plastics, rubber, paints, anti-corrosion coatings etc.); drilling fluids; glass wool; wire and cable industry; sound-absorbing materials; cosmetics; insulation material in electrical engineering technology; fire-extinguishing powders; lubricants; ceramics

Output:	
Mining output:	314,000 t
Largest mining countries:	China (30.3 %), Madagascar (21.9 %), USA (11 %)
Country concentration:	1,663
Weighted country risk:	0.10
Trade:	
Crude mica and mica rifted into sheets or splittings (HS 252510)[1]:	169,000 t
Largest net exporters:	India (58.8 %), Madagascar (32.5 %), Norway (4 %)
Country concentration:	4,545
Weighted country risk:	–0.23
Mica powder (HS 252520):	261,000 t
Largest net exporters:	China (52.4 %), India (29.3 %), Canada (5.2 %)
Country concentration:	3,672
Weighted country risk:	0.06
Mica waste (HS 252530):	54,700 t
Largest net exporters:	Madagascar (52.3 %), India (46.1 %), Pakistan (1.2 %)
Country concentration:	4,863
Weighted country risk:	–0.45
Molybdenum	
Use:	Steel alloying (HSLA steels; stainless steels, tool steels etc.); cast iron; superalloys; in catalysts; lubricants; electrical engineering technology (e. g. in TFTs; thin-film solar cells); pigments
Output:	
Mining output:	310,000 t cont.
Largest mining countries:	China (38.7 %), Chile (19.1 %), USA (16.5 %)
Country concentration:	2,300
Weighted country risk:	0.14
Ferromolybdenum output:	176,000 t
Largest production countries:	China (81.7 %), Chile (8.2 %), Armenia (3.8 %)
Country concentration:	6,763
Weighted country risk:	–0.13
Trade:	
Molybdenum ores and concentrates (excl. roasted) (HS 261390):	116,000 t
Largest net exporters:	Peru (48.9 %), USA (20.2 %), Armenia (14 %)

Country concentration:	3,075
Weighted country risk:	0.15
Molybdenum oxides and hydroxides (HS 282570):	23,600 t
Largest net exporters:	Chile (44.3 %), Netherlands (18.8 %), Iran (17 %)
Country concentration:	2,685
Weighted country risk:	0.49
Molybdates (HS 284170)[1]:	57,200 t
Largest net exporters:	Laos Democratic Republic (84.4 %), Netherlands (6 %), Viet Nam (2.9 %)
Country concentration:	7,176
Weighted country risk:	–0.55
Unwrought molybdenum, incl. bars (rods) obtained simply by sintering (HS 810294):	2,810 t
Largest net exporters:	China (71.4 %), Russia (19.2 %), United Kingdom (3.8 %)
Country concentration:	5,497
Weighted country risk:	–0.20
Molybdenum waste and scrap (excl. ash and residues containing molybdenum) (HS 810297):	3,540 t
Largest net exporters:	Brazil (36.6 %), China (32 %), France (9.3 %)
Country concentration:	2,517
Weighted country risk:	0.10
Nickel	
Use:	Steel alloying (corrosion-resistant steel); alloys; superalloys; gas turbines; rocket engines; metal coatings; coins; catalysts; batteries
Output:	
Mining output:	2.43 m t cont.
Largest mining countries:	Indonesia (31.5 %), Philippines (13.5 %), Russia (9.8 %)
Country concentration:	1,479
Weighted country risk:	0.03
Ferronickel output:	379,000 t cont.
Largest production countries:	New Caledonia (17 %), Brazil (15.7 %), Republic of Korea (12 %)
Country concentration:	1,061
Weighted country risk:	0.09

Refinery output:	2.48 m t cont.
Largest production countries:	China (29.9 %), Indonesia (25.4 %), Russia (6.2 %)
Country concentration:	1,706
Weighted country risk:	0.20
Trade:	
Nickel ores and concentrates (HS 260400)[1]:	43.8 m t
Largest net exporters:	Philippines (74.5 %), New Caledonia (17.1 %), Guatemala (3.5 %)
Country concentration:	5,855
Weighted country risk:	–0.26
Ferronickel (HS 720260)[1]:	3.90 m t
Largest net exporters:	Indonesia (71.4 %), New Caledonia (6.4 %), Brazil (5.4 %)
Country concentration:	5,206
Weighted country risk:	–0.08
Nickel mattes (HS 750110)[1]:	378,000 t
Largest net exporters:	Canada (34.6 %), Russia (32 %), Indonesia (24.7 %)
Country concentration:	2,861
Weighted country risk:	0.32
Niobium	
Use:	Steel alloying (stainless steels); alloys; superalloys (aircraft turbines); electrolyte capacitors; catalyst
Output:	
Mining output:	68,000 t cont.
Largest mining countries:	Brazil (88 %), Canada (9.4 %), Nigeria (1.1 %)
Country concentration:	7,837
Weighted country risk:	–0.07
Ferroniobium output:	64,900 t cont.
Largest production countries:	Brazil (89.9 %), Canada (9.6 %), Russia (0.6 %)
Country concentration:	8,169
Weighted country risk:	–0.05
Trade:	
Ferroniobium (HS 720293):	79,800 t
Largest net exporters:	Brazil (88.7 %), Canada (10.1 %), Singapore (1.2 %)
Country concentration:	7,964
Weighted country risk:	–0.02
Palladium	
Use:	Catalytic converters; chemical industry; dental technology; electrical engineering technology; investment; jewellery

Output:	
Mining output:	204 t cont.
Largest mining countries:	Russia (45.7 %), South Africa (32.6 %), USA (7.2 %)
Country concentration:	3,288
Weighted country risk:	–0.18
Perlite	
Use:	Lightweight aggregates (concrete, plasters, mortar); loose insulation; filter medium; gardening; cryogenic insulation; fillers; refractory products; sorbents for oil and chemicals; additive in paints; fluxes in the ceramics industry; scouring agents
Output:	
Mining output:	4.36 m t
Largest mining countries:	China (34.4 %), Turkey (26.3 %), Greece (16.5 %)
Country concentration:	2,291
Weighted country risk:	–0.04
Phosphate	
Use:	Fertilisers, foods and feeds; industrial applications (e. g. cleaning, anti-corrosion and fire-proofing agents)
Output:	
Mining output:	69.3 m t P_2O_5
Largest mining countries:	China (39.4 %), Morocco (17.2 %), USA (9.5 %)
Country concentration:	2,057
Weighted country risk:	–0.16
Trade:	
Natural calcium phosphates and natural aluminium calcium phosphates, natural and phosphatic chalk (unground) (HS 251010):	20.2 m t
Largest net exporters:	Morocco (51.1 %), Jordan (22.3 %), Peru (15.4 %)
Country concentration:	3,400
Weighted country risk:	–0.25
Natural calcium phosphates and natural aluminium calcium phosphates, natural and phosphatic chalk (unground) (HS 251020)[1]:	11.5 m t
Largest net exporters:	Morocco (47.8 %), Egypt (15.2 %), Jordan (13.4 %)
Country concentration:	2,817
Weighted country risk:	–0.34

Diammonium phosphate (HS 310530):	14.1 m t
Largest net exporters:	China (40.2 %), Morocco (39.4 %), Russia (10.9 %)
Country concentration:	3,309
Weighted country risk:	–0.24
Platinum	
Use:	Catalytic converters; jewellery; investment; chemical industry; glass; medical technology and bioengineering; electrical engineering technology; crude oil industry
Output:	
Mining output:	163 t cont.
Largest mining countries:	South Africa (68.8 %), Russia (13.4 %), Zimbabwe (9.2 %)
Country concentration:	5,024
Weighted country risk:	–0.07
Trade:	
Platinum, unwrought or in powder form (HS 711011)[1]:	287 t
Largest net exporters:	South Africa (42.2 %), Spain (26.2 %), Hungary (15.4 %)
Country concentration:	2,787
Weighted country risk:	0.33
Waste and scrap of platinum (incl. metal clad with platinum, and other waste and scrap containing platinum or platinum compounds) (HS 711292)[1]:	27,900 t
Largest net exporters:	South Africa (56.8 %), United Kingdom (7.3 %), Canada (6.8 %)
Country concentration:	3,416
Weighted country risk:	0.44
Potash	
Use:	Fertiliser, industrial chemicals for the production of potassium and potassium compounds
Output:	
Mining output:	43.3 m t K_2O
Largest mining countries:	Canada (31.7 %), Belarus (17.5 %), Russia (15.9 %)
Country concentration:	1,823
Weighted country risk:	0.33

Pumice	
Use:	Lightweight aggregates; dimension stones; pozzolans; abrasives and polishing agents; sorbents (plant soil; cat litter); fillers; carrier material (for catalysts, pesticides etc.); road construction material; gardening and landscaping; filter medium; fluxes in ceramic bodies
Output:	
Mining output:	16.5 m t
Largest mining countries:	Turkey (32.7 %), Uganda (6.8 %), Greece (5.8 %)
Country concentration:	1,349
Weighted country risk:	–0.19
Pyrophyllite	
Use:	Refractory products; ceramics; glass; filler and carrier material (biocides, paints, cosmetics, rubber, plastic, paper etc.); pigment; construction materials (white Portland cement, light road construction material)
Output:	
Mining output:	958,000 t
Largest mining countries:	Republic of Korea (32.8 %), Japan (16.7 %), India (15.6 %)
Country concentration:	1,927
Weighted country risk:	0.43
Rare earths	
Use:	Magnets (Nd-Fe-B, Sm-Co); alloys (e. g. for NiMH batteries); chemical and crude oil catalysts; polishing agents (CeO_2); light bulbs; special glasses; ceramics (yttria-stabilised ZrO_2 ceramics, glazing)
Output:	
Mining output:	224,000 t REO
Largest mining countries:	China (62.4 %), USA (17.9 %), Myanmar (8.4 %)
Country concentration:	4,332
Weighted country risk:	0.00
Refinery output:	221,000 t REO
Largest production countries:	China (91.3 %), Malaysia (6.6 %), Estonia (1.2 %)
Country concentration:	8,380
Weighted country risk:	–0.20
Trade:	
Cerium compounds (HS 284610)[1]:	16,000 t
Largest net exporters:	Malaysia (34.6 %), China (33.4 %), France (22.9 %)
Country concentration:	2,895
Weighted country risk:	0.31

Rhenium	
Use:	Rhenium-nickel superalloys (e. g. for gas turbines); platinum-rhenium catalysts; alloys
Output:	
Refinery output (by-products):	59.3 t cont.
Largest production countries:	Chile (50.6 %), Poland (16 %), USA (14.9 %)
Country concentration:	3,148
Weighted country risk:	0.60
Rhodium	
Use:	Catalytic converters; chemical industry; glass; electrical engineering technology
Output:	
Mining output:	18.9 t cont.
Largest mining countries:	South Africa (78.8 %), Russia (9.5 %), Zimbabwe (6.9 %)
Country concentration:	6,353
Weighted country risk:	–0.10
Trade:	
Rhodium, unwrought or in powder form (HS 711031)[1]:	33.9 t
Largest net exporters:	South Africa (66 %), Belgium (14.1 %), United Kingdom (5.5 %)
Country concentration:	4,636
Weighted country risk:	0.34
Ruthenium	
Use:	Electronics (wear-resistant electrical contacts, connectors, thick-film resistors in electronic circuits, chip resistors), alloys with platinum, palladium, titanium, tungsten carbide etc. for technical applications, machine tool industry, oil, gas and chemical industries; production of rich black surfaces for decorative applications such as jewellery or bathroom fixtures
Output:	
Mining output:	27.1 t cont.
Largest mining countries:	South Africa (92.5 %), Zimbabwe (3.8 %), Russia (3.7 %)
Country concentration:	8,588
Weighted country risk:	–0.01
Selenium	
Use:	Metallurgy; glass; fertiliser; animal feed; pharmaceuticals; chemical industry; pigments; electrical engineering technology; thin-film solar cells

Output:	
Refinery output (by-products):	4,050 t cont.
Largest production countries:	China (34.6 %), Japan (18.1 %), Republic of Korea (9.8 %)
Country concentration:	1,764
Weighted country risk:	0.48
Silicon	
Use:	Chemicals (silicones for moulding and sealing materials, paints); semiconductors; micro-chips; solar cells; aluminium alloying
Output:	
Refinery output:	3.04 m t
Largest production countries:	China (72.3 %), Norway (6.9 %), Brazil (6.6 %)
Country concentration:	5,346
Weighted country risk:	0.03
Trade:	
Silicon, containing < 99.99 % by weight of silicon (HS 280469):	1.08 m t
Largest net exporters:	China (57 %), Norway (17.2 %), Brazil (16.7 %)
Country concentration:	3,841
Weighted country risk:	0.21
Silicon dioxide (HS 281122)[1]:	1.18 m t
Largest net exporters:	China (65.6 %), Norway (10.1 %), Germany (8.7 %)
Country concentration:	4,525
Weighted country risk:	0.25
Carbides of silicon, whether or not chemically defined (HS 284920):	436,000 t
Largest net exporters:	China (55.1 %), Netherlands (12.3 %), Russia (10.2 %)
Country concentration:	3,393
Weighted country risk:	–0.01
Silver	
Use:	Coins and medals; electrical engineering technology; optical applications; solders; jewellery; silverware; medical products; photography
Output:	
Mining output:	24,700 t cont.
Largest mining countries:	Mexico (22.4 %), China (13.8 %), Peru (11 %)
Country concentration:	1,019
Weighted country risk:	0.00

Trade:	
Powder of silver (incl. silver plated with gold or platinum) (HS 710610):	92,600 t
Largest net exporters:	Mexico (94.3 %), Japan (5 %), USA (0.5 %)
Country concentration:	8,922
Weighted country risk:	–0.35
Silver, incl. silver plated with gold or platinum, unwrought (excl. silver in powder form) (HS 710691):	2.93 m t
Largest net exporters:	Mexico (99.4 %), China (0.1 %), Hong Kong (0.1 %)
Country concentration:	9,888
Weighted country risk:	–0.44
Strontium minerals	
Use:	Pyrotechnics; glass (e. g. production of LCD and plasma screens, special glasses, cathode ray tubes); ceramics; ferrites (magnets); chemical industry; zinc electrolysis; aluminium industry
Output:	
Mining output:	461,000 t
Largest mining countries:	Iran (43.1 %), Spain (26.4 %), China (17.5 %)
Country concentration:	3,028
Weighted country risk:	–0.44
Talcum	
Use:	Ceramic products (e. g. steatite); cellulose production; filler (paper, plastics, rubber, paints, bitumen and asphalt concrete etc.); release agent; lubricant; pharmaceuticals; cosmetics
Output:	
Mining output:	5.96 m t
Largest mining countries:	India (26.8 %), China (21.8 %), Brazil (10.9 %)
Country concentration:	1,482
Weighted country risk:	0.13
Tantalum	
Use:	Microcapacitors (electrolyte capacitors in vehicle electronics, computers, mobile telephones, aerospace industry etc.); alloys (carbide steels for cutting tools, superalloys, chemical process equipment, nuclear reactors, rocket parts, implants etc.); special glasses
Output:	
Mining output:	1,880 t cont.

Largest mining countries:	DR Congo (30.2 %), Brazil (25 %), Nigeria (13.8 %)
Country concentration:	1,936
Weighted country risk:	–0.77
Trade:	
Unwrought tantalum, incl. bars and rods of tantalum obtained simply by sintering; tantalum powders (HS 810320)[1]:	877 t
Largest net exporters:	China (46.7 %), Germany (19 %), Japan (13 %)
Country concentration:	2,847
Weighted country risk:	0.35
Articles of tantalum (n. e. s.) (HS 810390):	319 t
Largest net exporters:	China (34.5 %), USA (32.6 %), Turkey (15.8 %)
Country concentration:	2,615
Weighted country risk:	0.16
Tin	
Use:	Tin solder; packaging (tinplate); chemicals; brass and bronze; float glass
Output:	
Mining output:	300,000 t cont.
Largest mining countries:	China (29.3 %), Indonesia (27 %), Myanmar (12.8 %)
Country concentration:	1,883
Weighted country risk:	–0.35
Refinery output:	346,000 t cont.
Largest production countries:	China (48.6 %), Indonesia (18.2 %), Malaysia (6.5 %)
Country concentration:	2,823
Weighted country risk:	–0.08
Trade:	
Tin ores and concentrates (HS 260900)[1]:	181,000 t
Largest net exporters:	Myanmar (80.3 %), Australia (8.3 %), DR Congo (2.9 %)
Country concentration:	6,534
Weighted country risk:	–0.73
Unwrought tin, not alloyed (HS 800110):	144,000 t
Largest net exporters:	Indonesia (45.3 %), Peru (13.8 %), Malaysia (11.4 %)
Country concentration:	2,523
Weighted country risk:	0.10

Titanium	
Use:	TiO_2 pigments in paints, plastics, paper, glass, ceramics etc.; titanium metal for steel, alloys, superalloys in the aerospace industry, medical implants, chemical equipment, petrochemical industry, automotive industry, deoxidisation of steel; coating of welding rods
Output:	
Mining output:	5.14 m t TiO_2
Largest mining countries:	Australia (20.3 %), South Africa (18.5 %), Ukraine (10.4 %)
Country concentration:	1,113
Weighted country risk:	0.36
Refinery output:	227,000 t cont.
Largest production countries:	China (54.3 %), Japan (21.7 %), Russia (13.7 %)
Country concentration:	3,635
Weighted country risk:	0.05
Trade:	
Titanium oxides (HS 282300):	131,000 t
Largest net exporters:	China (53 %), India (12.6 %), Republic of Korea (11 %)
Country concentration:	3,230
Weighted country risk:	0.25
Ferrotitanium and ferrosilicotitanium (HS 720291):	43,000 t
Largest net exporters:	Russia (45.2 %), United Kingdom (27.5 %), Ukraine (11.8 %)
Country concentration:	3,021
Weighted country risk:	0.12
Unwrought titanium; titanium powders (HS 810820):	41,100 t
Largest net exporters:	Japan (47.4 %), Kazakhstan (24.2 %), Saudi Arabia (9.9 %)
Country concentration:	3,056
Weighted country risk:	0.49
Tungsten	
Use:	Carbide; tungsten metal; steels; tungsten alloys and super alloys for tool steels; heatresistant steels; rolling machines; cutting tools; drill bits; inserts; moulds; turbines; filaments; electrical contacts; electrodes; cathodes; thin-film transistors etc.; chemicals; lubricants
Output:	
Mining output:	83,700 t cont.

Largest mining countries:	China (85.4 %), Viet Nam (5.4 %), Russia (2.7 %)
Country concentration:	7,328
Weighted country risk:	–0.27
Trade:	
Bases, inorganic, and metal oxides, hydroxides and peroxides, n. e. s. (tungsten oxides & hydroxides) (HS 282590)[1,2]:	5,660 t
Largest net exporters:	China (68.9 %), India (16 %), Poland (10.3 %)
Country concentration:	5,121
Weighted country risk:	–0.09
Tungstates (wolframates) (HS 284180)[1]:	4,860 t
Largest net exporters:	Viet Nam (39.5 %), Taiwan (34.2 %), Philippines (15.2 %)
Country concentration:	2,997
Weighted country risk:	0.26
Ferrotungsten and ferrosilicotungsten (HS 720280):	3,360 t
Largest net exporters:	Russia (47.4 %), China (44.7 %), Viet Nam (4.6 %)
Country concentration:	4,273
Weighted country risk:	–0.43
Tungsten powders (HS 810110)[1]:	4,930 t
Largest net exporters:	China (48.9 %), Hong Kong (13.8 %), Austria (13.5 %)
Country concentration:	3,008
Weighted country risk:	0.43
Unwrought tungsten, incl. bars and rods of tungsten obtained simply by sintering (HS 810194)[1]:	2,180 t
Largest net exporters:	China (62.6 %), USA (19 %), Ireland (8.7 %)
Country concentration:	4,370
Weighted country risk:	0.20
Vanadium	
Use:	Steel alloying (structural and tool steels, vehicle and aircraft construction, shipbuilding); catalysts (vanadium phosphate catalyst); ceramics; chemicals, vanadium electrolyte solution in redox flow electricity storage units;
Output:	
Mining output:	107,000 t cont.

Largest mining countries:	China (65.9 %), Russia (18.3 %), South Africa (8.1 %)
Country concentration:	4,785
Weighted country risk:	–0.31
Trade:	
Vanadium oxides and hydroxides (HS 282530):	28,100 t
Largest net exporters:	Brazil (40.8 %), Russia (32.8 %), South Africa (22.8 %)
Country concentration:	3,267
Weighted country risk:	–0.26
Vermiculite	
Use:	Landscaping and gardening; additive (concrete, plaster, mortar, heat and soundproofing, fire safety); insulation material; packaging technology; adsorbents; filler and carrier material
Output:	
Mining output:	369,000 t
Largest mining countries:	South Africa (32 %), USA (27.1 %), Brazil (13.6 %)
Country concentration:	2,082
Weighted country risk:	0.08
Wollastonite	
Use:	Ceramics; filler (e. g. plastics, rubber, thermosetting casting slips and moulding materials, pearlescent pigments); paints and plasters (substitute for glass and asbestos fibres in the plastics and paint industries); refractory products; refractory personal protective equipment; welding electrodes; brake linings
Output:	
Mining output:	1.22 m t
Largest mining countries:	China (73.2 %), Mexico (10.8 %), India (8.5 %)
Country concentration:	5,561
Weighted country risk:	–0.17
Zeolite	
Use:	Ion-exchange beds; adsorbents (desiccant); for separation processes; catalysts; pozzolans; lightweight aggregate; light-weight construction materials; filler for paper; mild abrasive; carrier material for pesticides, fungicides and herbicides
Output:	
Mining output:	959,000 t
Largest mining countries:	Georgia (14.1 %), Republic of Korea (13.6 %), Indonesia (13.6 %)
Country concentration:	1,050
Weighted country risk:	0.43

Zinc	
Use:	Galvanising of steel (anti-corrosion agent); zinc die casting alloys; brass; pharmaceuticals and cosmetics; paints; rubber; ceramics; animal feed; fertiliser; pigments
Output:	
Mining output:	12.2 m t cont.
Largest production countries:	China (33.8 %), Peru (10.9 %), Australia (10.7 %)
Country concentration:	1,511
Weighted country risk:	0.08
Refinery output:	13.8 m t cont.
Largest mining countries:	China (46 %), Republic of Korea (6.6 %), India (5.2 %)
Country concentration:	2,297
Weighted country risk:	0.25
Zirconium	
Use:	Ceramics (wall and floor tiles, bathroom and technical ceramics, glazing, enamel); chemicals; moulding material for foundry applications; refractory products; abrasives, glasses, explosives, nuclear reactor construction
Output:	
Mining output:	1.21 m t
Largest mining countries:	Australia (35.8 %), South Africa (25.7 %), Mozambique (8.6 %)
Country concentration:	2,152
Weighted country risk:	0.48
Trade:	
Unwrought zirconium; zirconium powders (HS 810920)[1]:	8,050 t
Largest net exporters:	South Africa (49 %), China (31.5 %), Germany (14.9 %)
Country concentration:	3,632
Weighted country risk:	0.21

[1] Net exports of major supplier countries, some derived from so-called mirror data (global imports from a specific country).
[2] Net exports based on extended national HS codes.

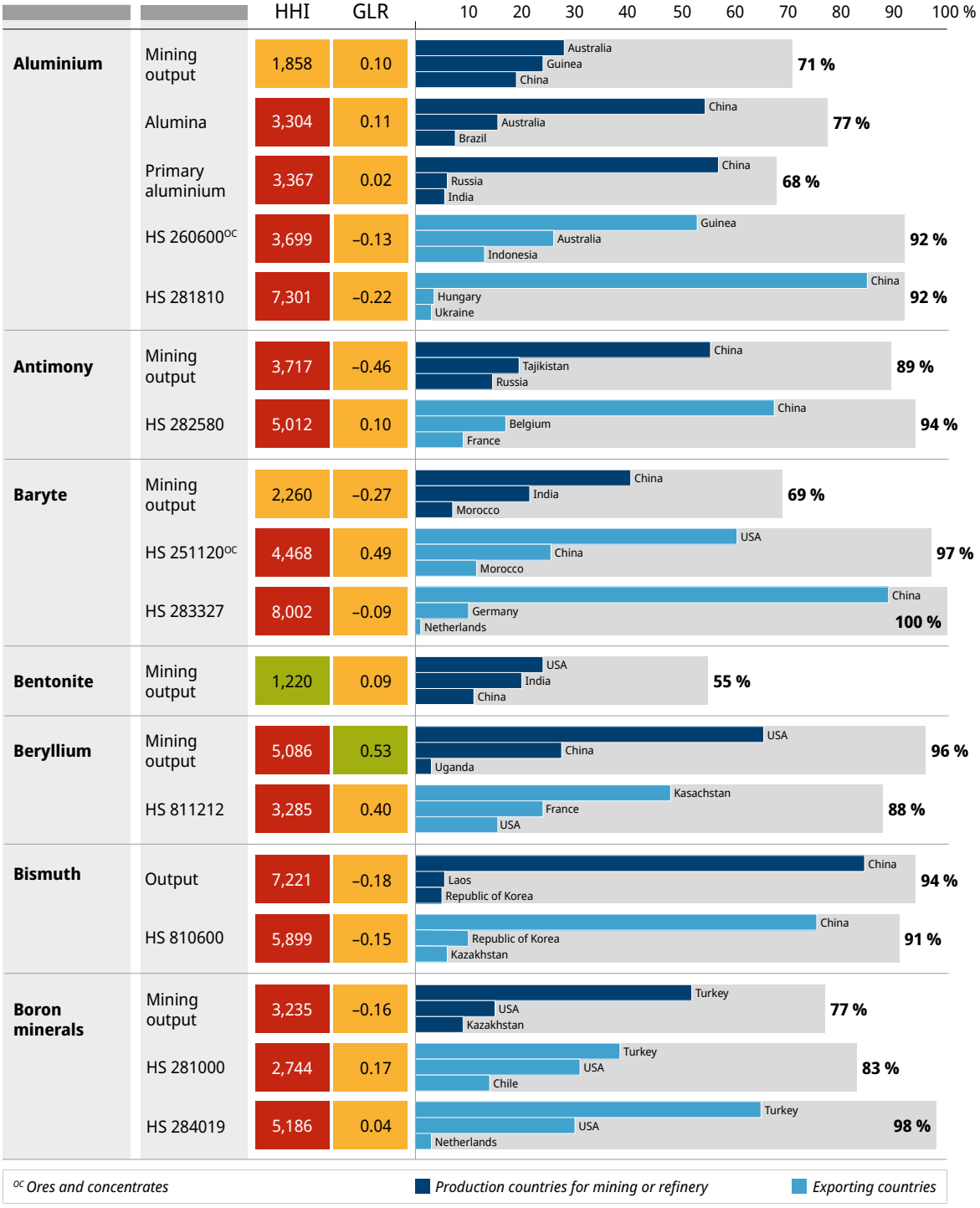


Fig. 7: Herfindahl-Hirschman index (HHI), weighted country risk (WCR) and shares of the three largest mining and refinery producer countries of all resources analysed, and export countries of the commodities with net exports in the critical range for 2020

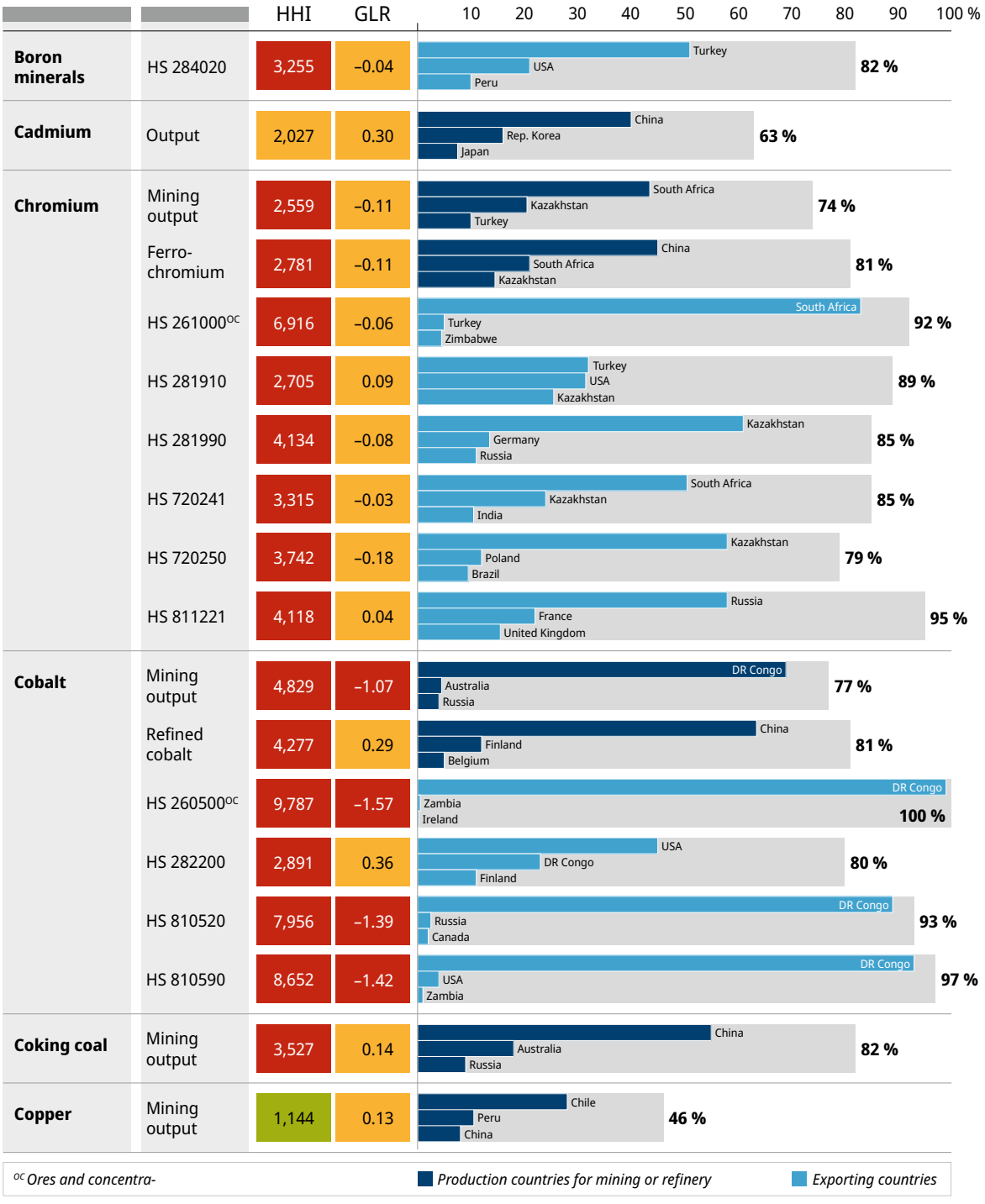


Fig. 7 (contd.): Herfindahl-Hirschman index (HHI), weighted country risk (WCR) and shares of the three largest mining and refinery producer countries of all resources analysed, and export countries of the commodities with net exports in the critical range for 2020

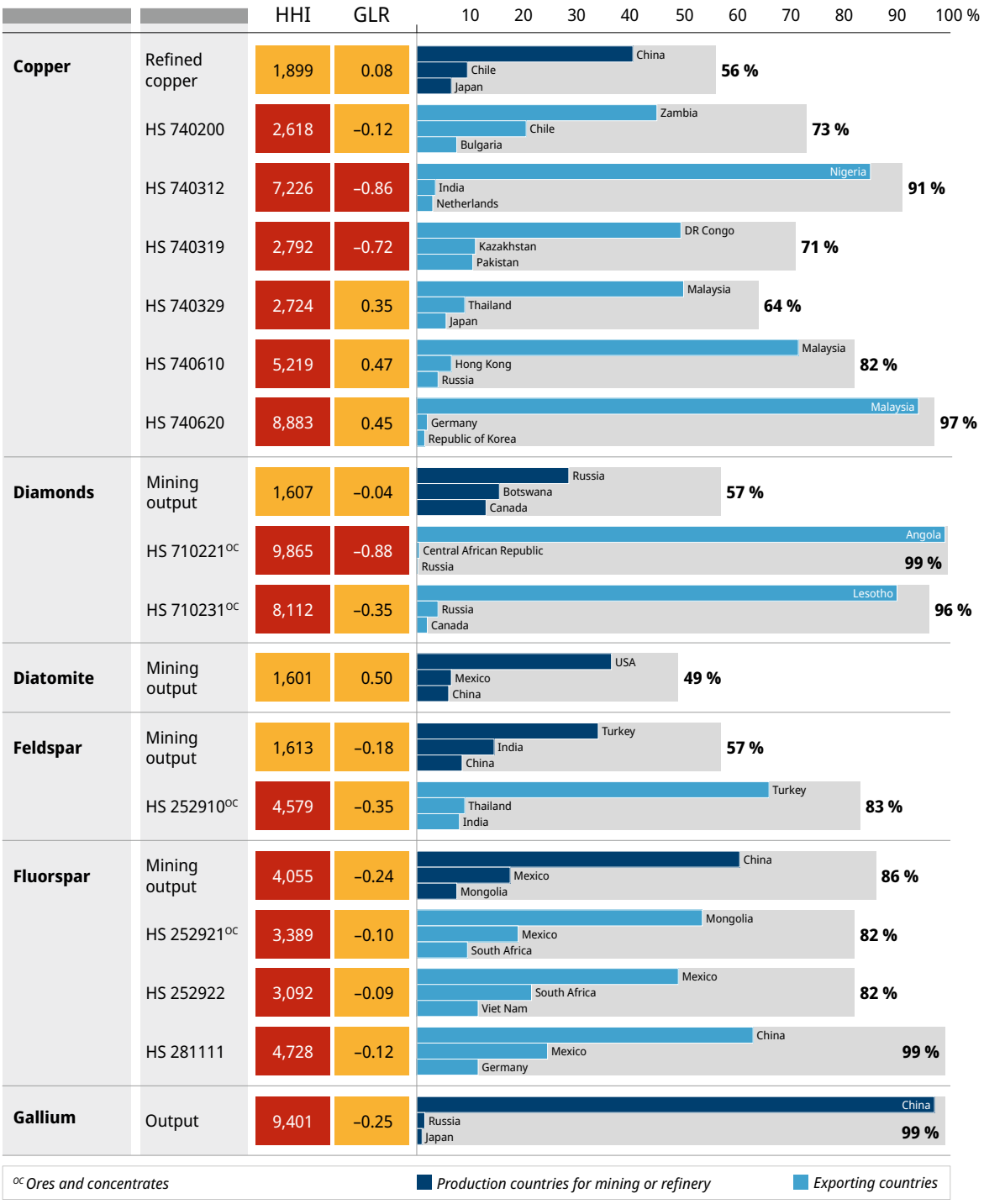


Fig. 7 (contd.): Herfindahl-Hirschman index (HHI), weighted country risk (WCR) and shares of the three largest mining and refinery producer countries of all resources analysed, and export countries of the commodities with net exports in the critical range for 2020

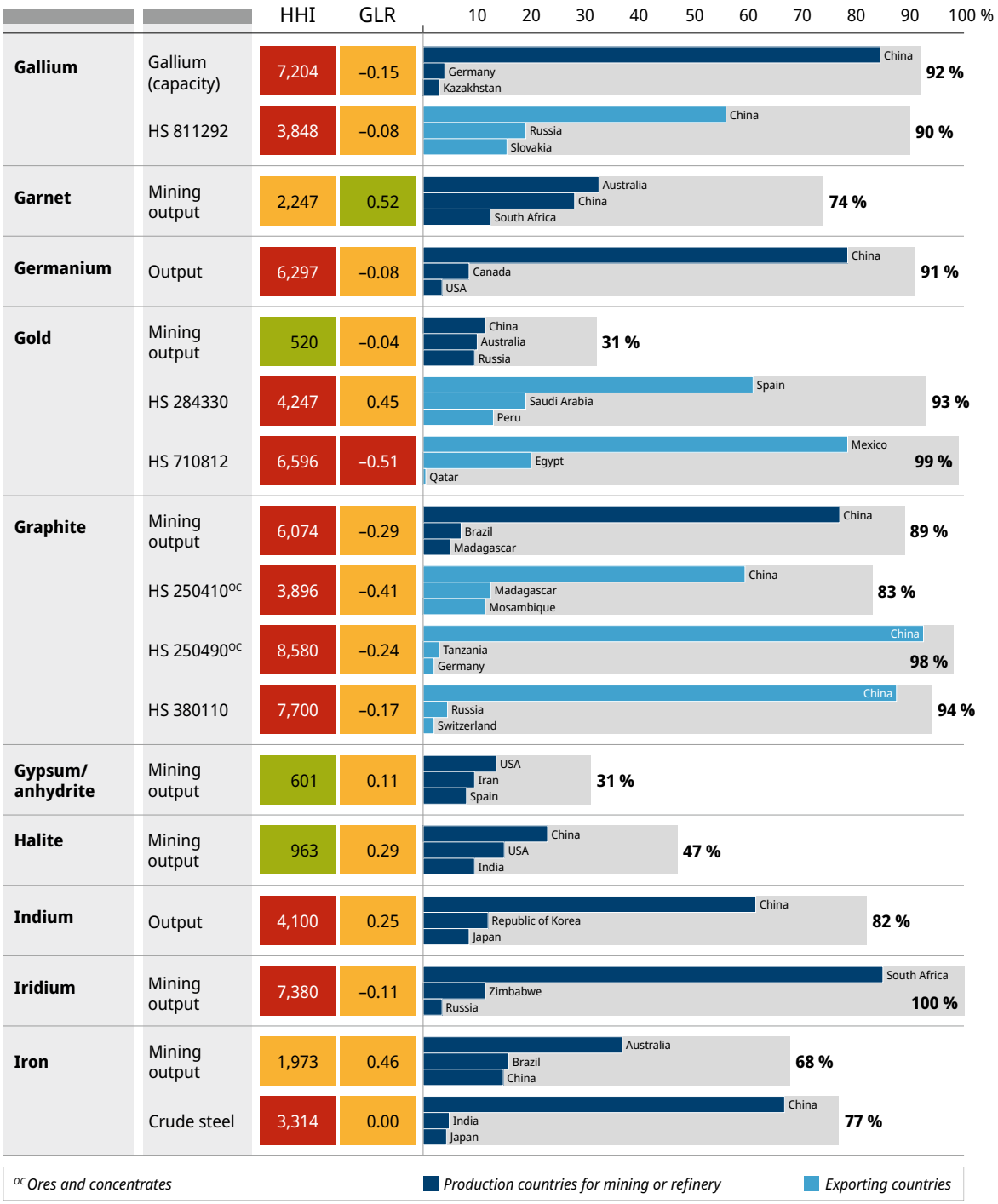


Fig. 7 (contd.): Herfindahl-Hirschman index (HHI), weighted country risk (WCR) and shares of the three largest mining and refinery producer countries of all resources analysed, and export countries of the commodities with net exports in the critical range for 2020

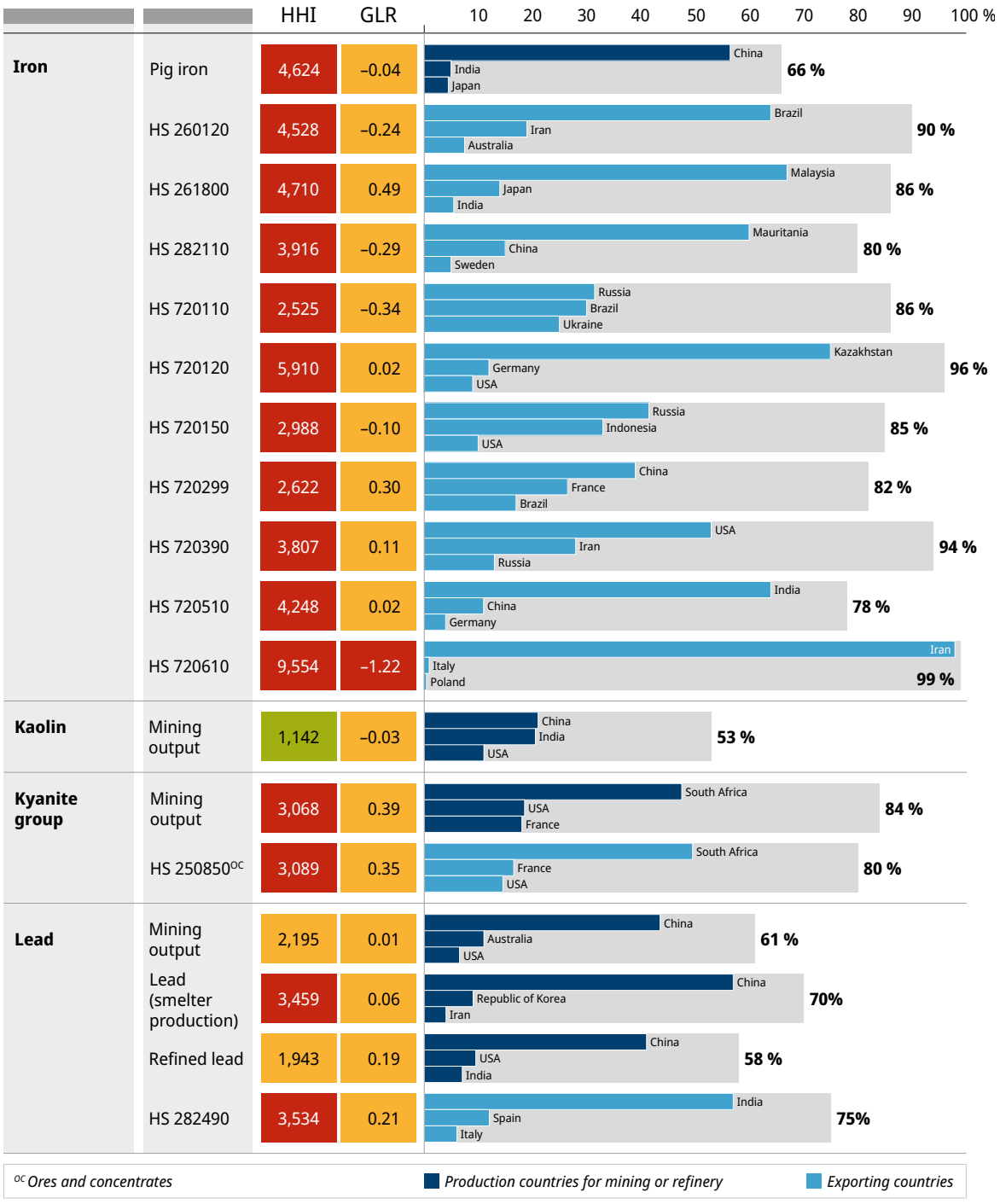


Fig. 7 (contd.): Herfindahl-Hirschman index (HHI), weighted country risk (WCR) and shares of the three largest mining and refinery producer countries of all resources analysed, and export countries of the commodities with net exports in the critical range for 2020

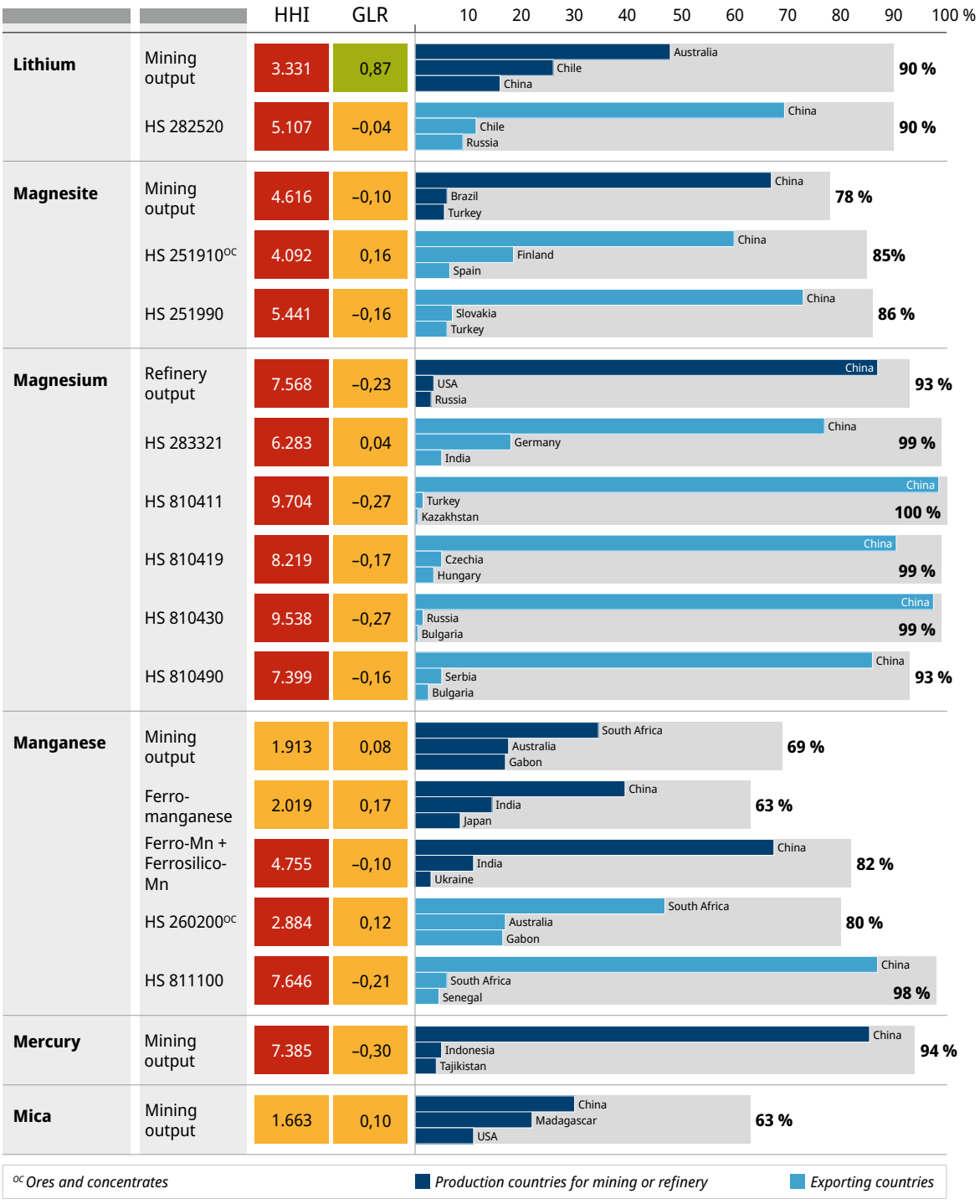


Fig. 7 (contd.): Herfindahl-Hirschman index (HHI), weighted country risk (WCR) and shares of the three largest mining and refinery producer countries of all resources analysed, and export countries of the commodities with net exports in the critical range for 2020

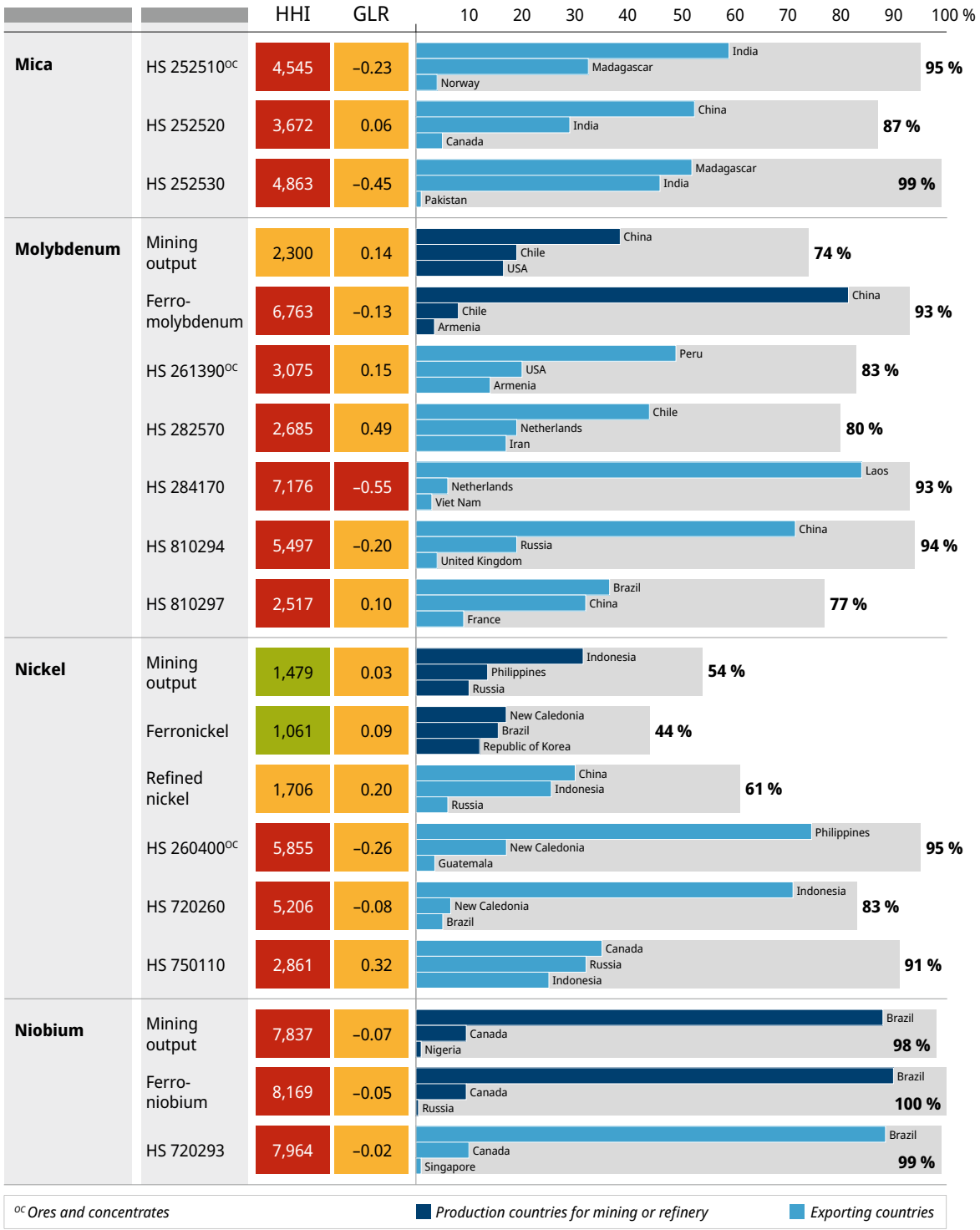


Fig. 7 (contd.): Herfindahl-Hirschman index (HHI), weighted country risk (WCR) and shares of the three largest mining and refinery producer countries of all resources analysed, and export countries of the commodities with net exports in the critical range for 2020

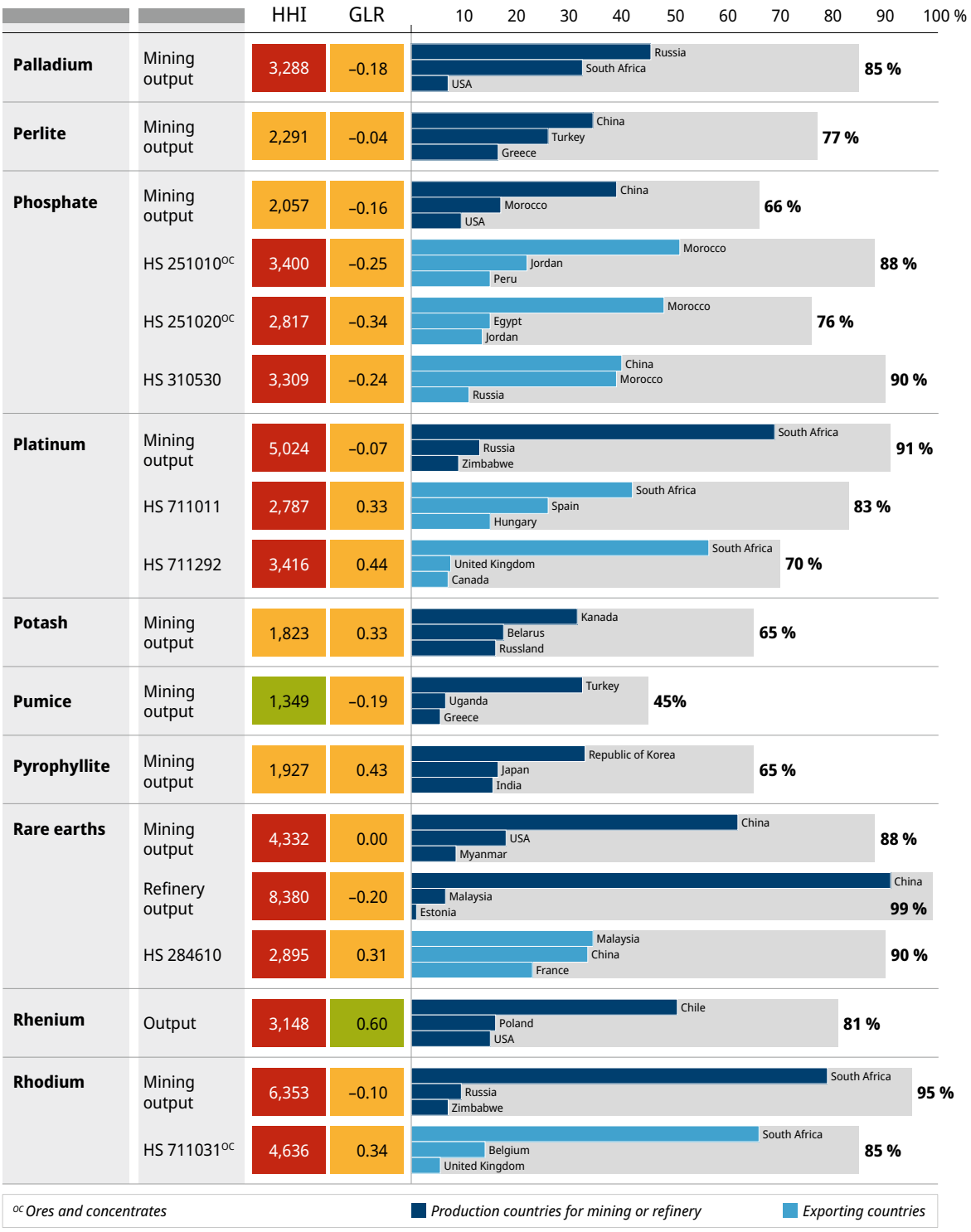


Fig. 7 (contd.): Herfindahl-Hirschman index (HHI), weighted country risk (WCR) and shares of the three largest mining and refinery producer countries of all resources analysed, and export countries of the commodities with net exports in the critical range for 2020

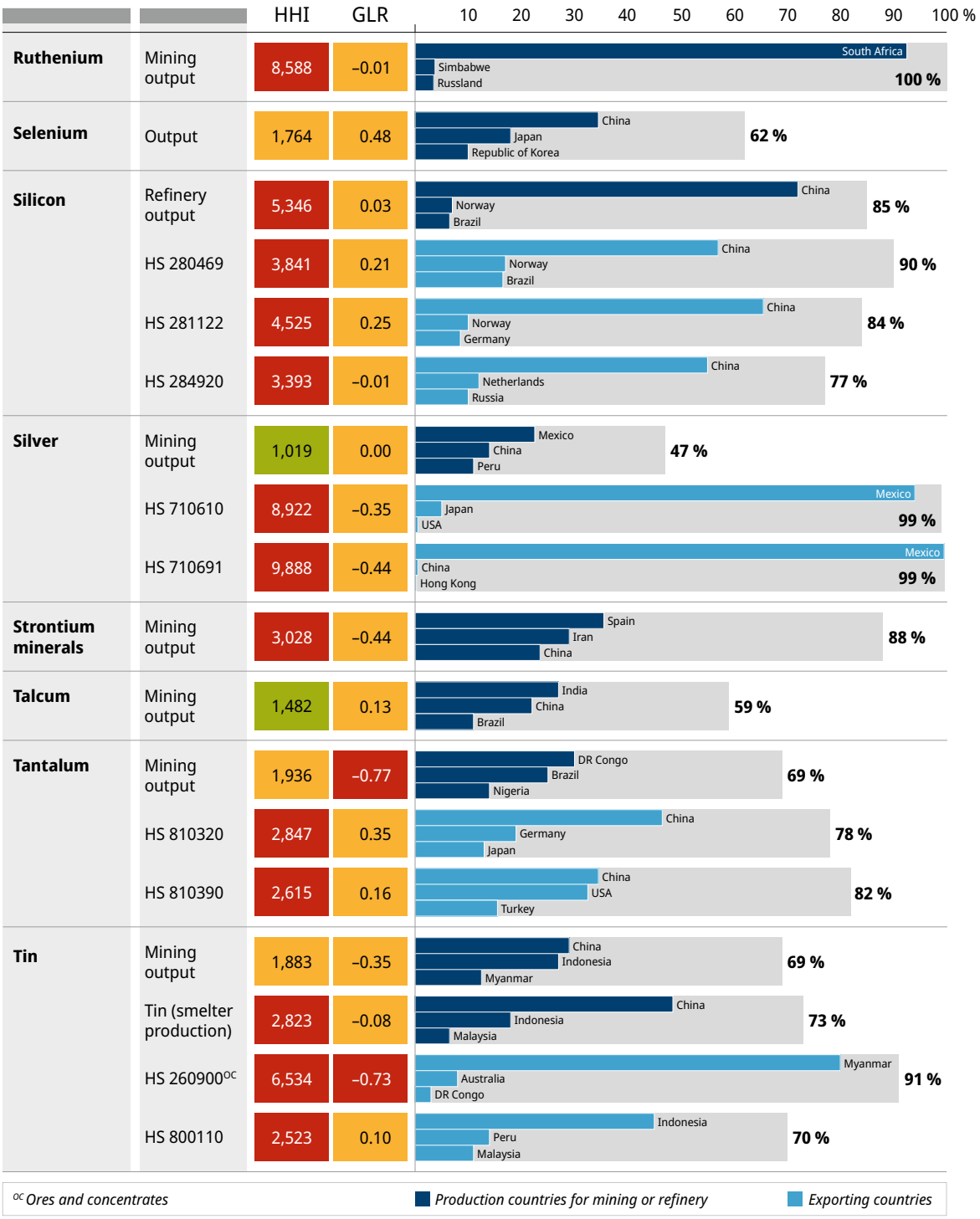


Fig. 7 (contd.): Herfindahl-Hirschman index (HHI), weighted country risk (WCR) and shares of the three largest mining and refinery producer countries of all resources analysed, and export countries of the commodities with net exports in the critical range for 2020

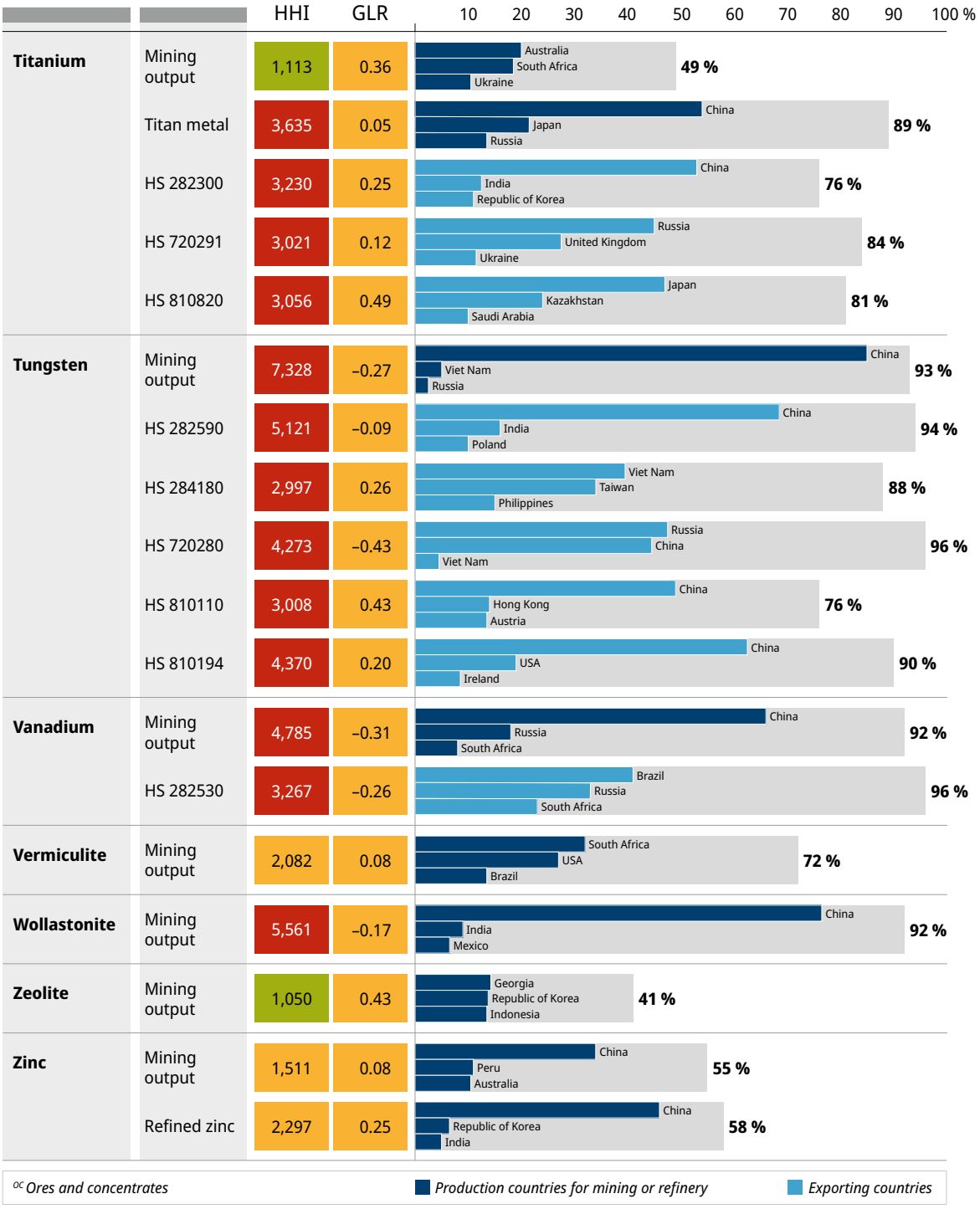


Fig. 7 (contd.): Herfindahl-Hirschman index (HHI), weighted country risk (WCR) and shares of the three largest mining and refinery producer countries of all resources analysed, and export countries of the commodities with net exports in the critical range for 2020

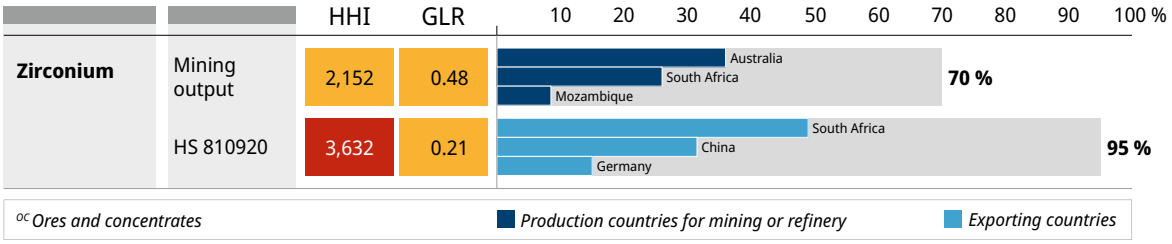
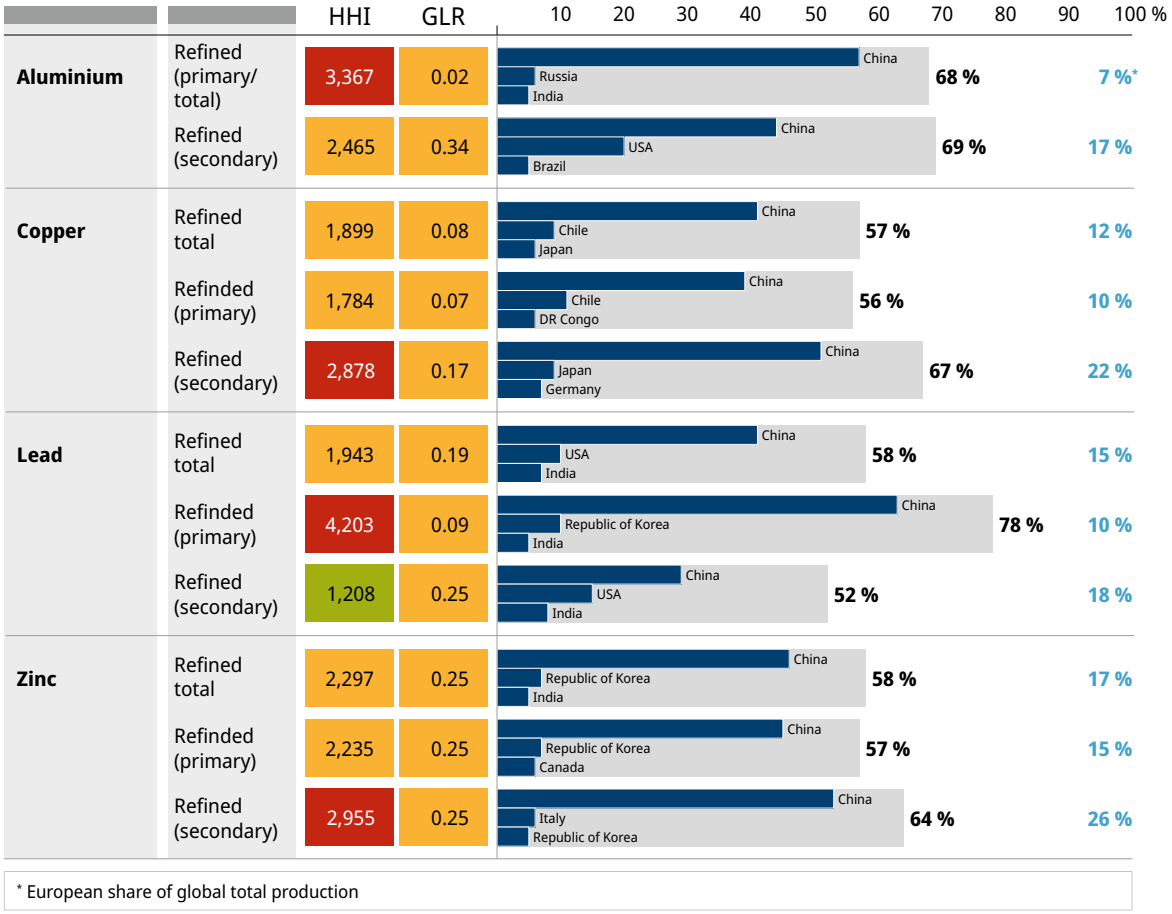


Fig. 7 (contd.): Herfindahl-Hirschman index (HHI), weighted country risk (WCR) and shares of the three largest mining and refinery producer countries of all resources analysed, and export countries of the commodities with net exports in the critical range for 2020



* European share of global total production

Fig. 8: Herfindahl-Hirschman index (HHI), weighted country risk (WCR) and shares of the three largest refinery producer countries for refinery output from primary and secondary raw materials of aluminium, lead, copper and zinc for 2020

Table 3: Changes in risk of all raw materials analysed and their commodities

Raw material / HS code	Specification	WCR			HHI			RG
		2018	2020	Change	2018	2020	Change	2020
Aluminium	Mining output	0.14	0.10	→	1,710	1,858	→	2
	Alumina output	0.08	0.11	→	3,477	3,304	→	3
	Primary aluminium output	0.00	0.02	→	3,337	3,367	→	3
260600[1)]	Aluminium ores and concentrates	–0.05	–0.13	→	3,334	3,699	↗	3
262040[1)]	Ash and residues containing mainly aluminium	0.86	0.86	→	1,341	998	↘	1
281810	Corundum, artificial, whether or not chemically defined	–0.28	–0.22	→	5,754	7,301	↑	3
281820	Alumina (excl. artificial corundum)	0.80	0.75	→	3,145	3,234	→	2
281830	Aluminium hydroxide	0.54	0.53	→	1,450	1,243	↘	1
282732	Aluminium chloride	0.82	0.62	↗	1,747	1,965	↗	1
283322	Sulphates of aluminium	0.11	0.02	→	1,066	1,450	↗	1
760110	Aluminium, not alloyed, unwrought	0.53	0.49	→	1,088	1,135	→	1
760120[1)]	Unwrought aluminium alloys	0.69	0.71	→	1,286	1,229	→	1
760200[1)]	Waste and scrap, of aluminium (excl. slags, scale and the like from iron and steel production)	1.04	1.02	→	812	899	→	1
Antimony	Mining output	–0.53	–0.46	→	3,701	3,717	→	3
261710[1)]	Aluminium ores and concentrates	–0.62	–0.28	↓	2,544	2,215	↘	2
282580	Antimony oxides	0.08	0.10	→	4,786	5,012	↗	3
811010[1)]	Unwrought antimony (metal); antimony powders	–0.38	–0.44	→	4,198	2,245	↓	2
811020	Antimony waste and scrap (excl. ash and residues containing antimony)	–0.08	0.59	↓	4,750	8,719	↑	2
Baryte	Mining output	–0.23	–0.27	→	1,855	2,260	↗	2
251110[1)]	Natural barium sulphate (barytes)	–0.27	–0.32	→	2,665	2,391	↘	2
251120[1)]	Natural barium carbonate (witherite), whether or not calcined (excl. barium oxide)	0.29	0.49	↓	3,711	4,468	↗	3
283327[1)]	Sulphates of barium	–0.07	–0.09	→	7,481	8,002	↗	3
Bentonite	Mining output	0.15	0.09	→	1,384	1,220	→	1
250810	Bentonite	0.14	0.03	↗	2,190	2,086	→	2
Beryllium	Mining output	0.64	0.53	↗	4,857	5,086	↗	2

Table 3 (contd.): Changes in risk of all raw materials analysed and their commodities

Raw material / HS code	Specification	WCR			HHI			RG
		2018	2020	Change	2018	2020	Change	2020
811212[1)]	Unwrought beryllium; beryllium powders	0.66	0.40	↑	1,370	3.285	↑	3
811213	Beryllium waste and scrap (excl. ash and residues containing beryllium)	1.69	1.32	↑	9,070	6,576	↓	2
Pumice	Mining output	–0.18	–0.19	→	1,542	1,349	→	1
Lead	Mining output	–0.02	0.01	→	2,020	2,195	→	2
	Lead (smelter production) output	–0.13	0.06	↘	6,451	3,459	↓	3
	Refined lead output	0.23	0.19	→	1,947	1,943	→	2
260700	Lead ores and concentrates	0.05	0.08	→	904	929	→	1
262029	Slag, ash and residues containing mainly lead (excl. leaded gasoline sludges and leaded anti-knock compound sludges)	1.38	0.97	↑	3,928	2,946	↘	2
282410	Lead monoxide (litharge, massicot)	0.68	0.57	↗	1,406	1,450	→	1
282490[1)]	Lead oxides (excl. monoxide [litharge, massicot])	0.57	0.21	↑	1,471	3,534	↑	3
780110	Unwrought lead, refined	0.64	0.53	↗	761	809	→	1
780199[1)]	Unwrought lead (excl. refined lead and lead containing by weight antimony as the principal other element)	0.91	1.03	↘	1,454	1,908	↗	1
780200	Lead waste and scrap (excl. ashes and residues from lead production [heading No. 2620], and ingots or other similar unwrought shapes)	1.07	1.13	→	938	1,069	→	1
Borate minerals	Mining output	–0.07	–0.16	→	3,872	3,235	↘	3
280450[1,2)]	Boron; tellurium (boron)	1.43	1.19	↑	3,269	2,269	↑	1
281000[1)]	Oxides of boron; boric acids	0.14	0.17	→	2,925	2,744	→	3
284011	Anhydrous disodium tetraborate (refined borax)	0.64	0.54	→	5,282	4,877	↘	2
284019[1)]	Disodium tetraborate (refined borax) (excl. anhydrous)	0.05	0.04	→	5,590	5,186	↘	3
284020[1)]	Borates (excl. disodium tetraborate [refined borax])	0.00	–0.04	→	3,239	3,255	→	3
284030[1)]	Peroxoborates (perborates)	0.90	0.84	→	3,652	3,337	↘	2
Chromium	Mining output	–0.08	–0.11	→	2,900	2,559	↘	3
	Ferrochromium output	–0.14	–0.11	→	2,477	2,781	↗	3

Table 3 (contd.): Changes in risk of all raw materials analysed and their commodities

Raw material / HS code	Specification	WCR			HHI			RG
		2018	2020	Change	2018	2020	Change	2020
261000	Chromium ores and concentrates	–0.12	–0.06	→	5,907	6,916	↑	3
281910[1)]	Chromium trioxide	0.17	0.09	→	2,924	6,660	↑	3
281990[1)]	Chromium oxides and hydroxides (excl. chromium trioxide)	–0.10	–0.08	→	4,284	4,134	→	3
720241	Ferrochromium, containing by weight > 4 % of carbon	–0.06	–0.03	→	3,607	3,315	↘	3
720249	Ferrochromium, containing by weight ≦ 4 % of carbon	–0.25	–0.25	→	2,597	2,386	↘	2
720250	Ferrosilicochromium	–0.05	–0.18	↙	5,301	3,742	↓	3
811221	Unwrought chromium; chromium powders	0.06	0.04	→	3,232	4,118	↗	3
811222	Chromium waste and scrap (excl. ash and residues containing chromium and chromium alloys containing > 10 % by weight of nickel)	0.84	0.75	→	4,271	4,987	↗	2
Diamonds	Mining output	0.03	–0.04	→	1,637	1,607	→	2
710221[1)]	Industrial diamonds unworked or simply sawn, cleaved or bruted	–0.87	–0.88	→	9,843	9,865	→	3
710231[1)]	Non-industrial diamonds unworked or simply sawn, cleaved or bruted (excl. industrial diamonds)	–0.06	–0.35	↑	4,609	8,112	↑	3
710510[1)]	Dust and powder of diamonds (incl. synthetic diamonds)	–0.14	0.89	↓	7,321	3,614	↓	2
Diatomite	Mining output	0.54	0.50	→	1,796	1,601	→	1
251200	Siliceous fossil meals, e. g. kieselguhr, tripolite and diatomite, and similar siliceous earths, whether or not calcined, of an apparent specific gravity of ≦ 1	0.16	0.19	→	1,423	1,797	↗	2
Kyanite group	Mining output	0.35	0.39	→	2,619	3,068	↗	3
250850	Andalusite, kyanite and sillimanite	0.27	0.35	→	3,536	3,089	↘	3
Iron	Mining output	0.50	0.46	→	1,990	1,973	→	2
	Pig iron output	–0.01	–0.04	→	3,917	4,624	↗	3
	Crude steel output	0.06	0.00	→	2,739	3,314	↗	3
260111	Non-agglomerated iron ores and concentrates, excl. roasted iron pyrites	0.94	0.90	→	4,663	4,393	↘	2

Table 3 (contd.): Changes in risk of all raw materials analysed and their commodities

Raw material / HS code	Specification	WCR			HHI			RG
		2018	2020	Change	2018	2020	Change	2020
260112	Agglomerated iron ores and concentrates (excl. roasted iron pyrites)	0.10	0.26	↘	1,322	1,447	→	1
260120	Roasted iron pyrites	0.39	–0.24	↓	5,975	4,528	↓	3
261800	Granulated slag (slag sand) from the manufacture of iron or steel	0.72	0.49	↑	2,136	4,710	↑	3
261900	Slag, dross, scalings and other waste from the manufacture of iron or steel (excl. granulated slag)	0.34	0.40	→	910	1,074	→	1
282110	Iron oxides and hydroxides	0.03	–0.29	↑	2,344	3,916	↑	3
720110	Non-alloy pig iron in pigs, blocks or other primary forms, containing, by weight, ≦ 0.5 % of phosphorus	–0.53	–0.34	↘	3,143	2,525	↘	3
720120[1)]	Non-alloy pig iron in pigs, blocks or other primary forms, containing, by weight, > 0.5 % of phosphorus	0.10	0.02	→	2,755	5,910	↑	3
720150	Alloy pig iron and spiegeleisen, in pigs, blocks or other primary forms	0.22	–0.10	↑	3,455	2,988	↘	3
720299	Ferroalloys (excl. ferromanganese, ferrosilicon, ferrosilicomanganese, ferrochromium, ferrosilicochromium, ferronickel, ferromolybdenum, ferrotungsten, ferrosilicotungsten, ferrotitanium, ferrosilicotitanium, ferrovanadium and ferroniobium)	0.28	0.30	→	3,067	2,622	↘	3
720310[1)]	Ferrous products obtained by direct reduction of iron ore (in lumps, pellets or similar forms)	–0.42	0.10	↓	2,179	1,767	↘	2
720390[1)]	Spongy ferrous products, obtained from molten pig iron by atomisation, iron of a purity of ≧ 99.94 % (in lumps, pellets or similar forms)	0.28	0.11	↗	3,735	3,807	→	3
720410	Waste and scrap, of cast iron (excl. radioactive)	0.81	0.85	→	773	1,833	↑	1
720421	Waste and scrap of stainless steel (excl. radioactive, and waste and scrap of batteries and electric accumulators)	0.95	1.01	→	879	918	→	1
720430	Waste and scrap of stainless steel (excl. radioactive, and waste and scrap of batteries and electric accumulators)	0.68	0.65	→	874	626	↘	1

Table 3 (contd.): Changes in risk of all raw materials analysed and their commodities

Raw material / HS code	Specification	WCR			HHI			RG
		2018	2020	Change	2018	2020	Change	2020
720441	Turnings, shavings, chips, milling waste, sawdust, filings, trimmings and stampings of iron or steel, whether or not in bundles	1.20	1.20	→	1,241	1,482	↘	1
720510[1)]	Granules, of pig iron, spiegeleisen, iron or steel (excl. granules of ferroalloys, turnings and filings of iron or steel)	–0.03	0.02	→	2,501	4,248	↑	3
720521[1)]	Powders, of alloy steel (excl. powders of ferroalloys and radioactive iron powders [isotopes])	1.55	1.51	→	4,278	3,957	↘	2
720610	Ingots, of iron and non-alloy steel (excl. remelted scrap ingots, continuous cast products, iron of heading 7203)	–0.96	–1.22	↑	9,020	9,554	↘	3
720690	Iron and non-alloy steel, in puddled bars or other primary forms (excl. ingots, remelted scrap ingots, continuous cast products, iron of heading 7203)	–0.50	0.89	↓	4,390	2,823	↓	2
Feldspar	Mining output	–0.06	–0.18	↘	1,095	1,613	↘	2
252910	Feldspar	–0.37	–0.35	→	4,920	4,579	↘	3
Fluorite	Mining output	–0.26	–0.24	→	3,870	4,055	→	3
252921[1)]	Fluorspar containing by weight ≦ 97 % calcium fluoride	–0.23	–0.10	↘	2,760	3,389	↘	3
252922[1)]	Fluorspar containing by weight > 97 % calcium fluoride	–0.19	–0.09	↘	2,313	3,092	↘	3
281111	Hydrogen fluoride “hydrofluoric acid”	–0.04	–0.12	→	4,077	4,728	↘	3
Gallium	Primary gallium output	–0.30	–0.25	→	9,244	9,401	→	3
	Production capacity primary gallium	–0.19	–0.15	→	7,030	7,204	→	3
811292[1,2)]	Unwrought hafnium, niobium (columbium), rhenium, gallium, indium, vanadium and germanium; powders and waste and scrap of these metals (excl. ash and residues) (gallium)	–0.07	–0.08	→	5,491	3,848	↓	3
Germanium	Refinery output (by-products)	–0.15	–0.08	→	5,658	6,297	↘	3
811292[1,2)]	Unwrought hafnium, niobium (columbium), rhenium, gallium, indium, vanadium and germanium; powders and waste and scrap of these metals (excl. ash and residues) (germanium)	0.95	1.16	↓	2,503	5,266	↑	2

Table 3 (contd.): Changes in risk of all raw materials analysed and their commodities

Raw material / HS code	Specification	WCR			HHI			RG
		2018	2020	Change	2018	2020	Change	2020
Gypsum/ anhydrite	Mining output	0.16	0.11	→	572	601	→	1
Mica	Mining output	0.21	0.10	↘	1,598	1,663	→	2
252510[1)]	Crude mica and mica rifted into sheets or splittings	–0.17	–0.23	→	4,946	4,545	↘	3
252520	Mica powder	0.02	0.06	→	3,670	3,672	→	3
252530	Mica waste	–0.34	–0.45	↘	5,489	4,863	↘	3
Gold	Mining output	–0.02	–0.04	→	491	520	→	1
284330[1)]	Gold compounds, inorganic or organic, whether or not chemically defined	1.47	0.45	↓	5,464	4,247	↓	3
710812	Gold (incl. gold plated with platinum), unwrought, for non-monetary purposes (excl. gold in powder form)	0.35	–0.51	↓	977	6,596	↓	3
710813	Gold (incl. gold plated with platinum), in semimanufactured forms, for non-monetary purposes	–0.02	0.19	↓	3,924	1,416	↓	1
Garnet	Mining output	0.49	0.52	→	2,092	2,247	→	1
251320	Emery; natural corundum, natural garnet and other natural abrasives (whether or not heat-treated)	0.31	0.33	→	2,155	2,238	→	2
Graphite	Mining output	–0.32	–0.29	→	5,947	6,074	→	3
250410[1)]	Natural graphite in powder or in flakes	–0.45	–0.41	→	4,068	3,896	→	3
250490[1)]	Natural graphite (excl. in powder or in flakes)	–0.33	–0.24	→	7,628	8,580	↘	3
380110[1)]	Artificial graphite (excl. retort graphite, retort carbon and goods of artificial graphite, incl. refractory materials based on artificial graphite)	–0.21	–0.17	→	6,744	7,700	↘	3
380120	Colloidal or semi-colloidal graphite	1.24	1.20	→	2,308	2,188	→	1
Indium	Refinery output (by-products)	0.24	0.25	→	3,980	4,100	→	3
811292[1,2)]	Unwrought hafnium, niobium (columbium), rhenium, gallium, indium, vanadium and germanium; powders and waste and scrap of these metals (excl. ash and residues) (indium)	0.80	0.85	→	2,753	3,166	↘	2

Table 3 (contd.): Changes in risk of all raw materials analysed and their commodities

Raw material / HS code	Specification	WCR			HHI			RG
		2018	2020	Change	2018	2020	Change	2020
Iridium	Mining output	0.00	–0.11	↙	7,198	7,380	→	3
Cadmium	Refinery output (by-products)	0.29	0.30	→	1,708	2,027	↗	2
810720	Unwrought cadmium; cadmium powders	0.79	0.75	→	1,989	1,583	↘	1
810730[1)]	Cadmium waste and scrap (excl. ash and residues containing cadmium)	0.79	1.43	↓	3,006	6,850	↑	2
Potash	Mining output	0.44	0.33	↙	1,831	1,823	→	2
Kaolin	Mining output	0.12	–0.03	↙	1,021	1,142	→	1
250700	Kaolin and other kaolinic clays, whether or not calcined	0.54	0.53	→	1,595	1,476	→	1
Cobalt	Mining output	–1.20	–1.07	↘	5,399	4,829	↘	3
	Refinery output	0.23	0.29	→	4,049	4,277	↗	3
260500[1)]	Cobalt ores and concentrates	–1.61	–1.57	→	9,396	9,787	↗	3
282200[1)]	Cobalt oxides and hydroxides; commercial cobalt oxides	–0.96	0.36	↓	5,243	2,891	↓	3
282739[1,2)]	Chlorides (excl. ammonium, calcium, magnesium, aluminium, nickel and mercury chloride)	1.02	1.07	→	3,940	5,676	↑	2
810520[1)]	Cobalt mattes and other intermediate products of cobalt metallurgy; unwrought cobalt; cobalt powders	–1.44	–1.39	→	8,136	7,956	→	3
810530[1)]	Cobalt waste and scrap (excl. ash and residues containing cobalt)	1.05	1.12	→	1,201	1,761	↗	1
810590[1)]	Articles of cobalt (n. e. s.)	0.21	–1.42	↑	2,379	8,652	↑	3
Coking coal	Mining output	0.18	0.14	→	3,161	3,527	↗	3
270400	Coke and semi-coke of coal, lignite or peat, whether or not agglomerated; retort carbon	–0.03	0.33	↓	2,329	2,140	→	2
270820[1)]	Pitch coke; obtained from coal tar or from other mineral tars	0.84	1.14	↓	2,075	2,621	↗	2
271311	Petroleum coke, non-calcined	1.11	0.86	↑	7,492	6,761	↘	2
271312	Petrolkoks, calciniert	0.76	0.55	↑	5,053	4,745	↘	2
Copper	Mining output	0.22	0.13	→	1,185	1,144	→	1
	Refinery output	0.15	0.08	→	1,742	1,899	→	2
260300	Copper ores and concentrates	0.33	0.32	→	2,199	2,216	→	2
262030[1)]	Ash and residues containing mainly copper	1.10	1.02	→	5,274	3,669	↓	2

Table 3 (contd.): Changes in risk of all raw materials analysed and their commodities

Raw material / HS code	Specification	WCR			HHI			RG
		2018	2020	Change	2018	2020	Change	2020
282550[1)]	Copper oxides and hydroxides	0.89	1.01	↘	2,952	3,174	↗	2
283325	Sulphates of copper	0.04	–0.06	↗	1,363	1,356	→	1
740100[1)]	Copper mattes; cement copper (precipitated copper)	0.32	0.76	↑	1,334	1,643	↗	1
740200[1)]	Copper, unrefined; copper anodes for electrolytic refining	0.04	–0.12	↗	3,316	2,618	↘	3
740311	Copper, refined, in the form of cathodes and sections of cathodes	0.39	0.17	↑	1,472	1,258	↘	1
740312[1)]	Copper, refined, in the form of wire-bars	–0.29	–0.86	↑	3,893	7,226	↑	3
740313	Copper, refined, in the form of billets	1.23	0.96	↑	4,732	3,120	↓	2
740319	Copper, refined, unwrought (excl. copper in the form of billets, wire-bars, cathodes and sections of cathodes)	–1.11	–0.72	↓	5,098	2,792	↓	3
740321	Copper-zinc base alloys (brass) unwrought	0.33	0.12	↑	943	859	→	1
740322	Copper-tin base alloys (bronze) unwrought	0.64	0.55	→	1,231	1,145	→	1
740329[1)]	Copper alloys unwrought (excl. copper-zinc base alloys [brass], copper-tin base alloys [bronze] and copper master alloys of heading 7405)	0.18	0.35	↘	1,865	2,724	↗	3
740400[1)]	Waste and scrap, of copper (excl. ingots or other similar unwrought shapes, of remelted copper waste and scrap, ashes and residues)	0.89	0.77	↗	856	1,037	→	1
740610	Copper powders, of non-lamellar structure (excl. grains of copper)	0.50	0.47	→	2,770	5,219	↑	3
740620	Copper powders, of lamellar structure, and flakes of copper (excl. grains of copper and spangles of heading 8308)	0.45	0.45	→	8,384	8,883	↗	3
Lithium	Mining output	1.14	0.87	↑	4,177	3,331	↘	2
282520	Lithium oxide and hydroxide	1.15	–0.04	↑	4,154	5,107	↗	3
283691[1)]	Lithium carbonates	0.68	0.65	→	5,872	6,088	↗	2
Magnesite	Mining output	–0.16	–0.10	→	4,340	4,616	↗	3
251910	Natural magnesium carbonate (magnesite)	–0.20	0.16	↓	3,882	4,092	↗	3

Table 3 (contd.): Changes in risk of all raw materials analysed and their commodities

Raw material / HS code	Specification	WCR			HHI			RG
		2018	2020	Change	2018	2020	Change	2020
251990	Fused magnesia; dead-burned (sintered) magnesia, whether or not containing small quantities of other oxides added before sintering; other magnesium oxide	–0.16	–0.16	→	4,929	5,441	↗	3
Magnesium	Refinery output	–0.24	–0.23	→	7,485	7,568	→	3
253020[1)]	Natural magnesium sulphates (kieserite and epsomite)	0.96	1.00	→	5,706	6,316	↗	2
281610	Hydroxide and peroxide of magnesium	0.55	0.62	→	1,462	2,603	↑	2
282731[1)]	Magnesium chloride	0.88	0.84	→	4,315	3,932	↘	2
283321	Sulphates; of magnesium	0.00	0.04	→	6,232	6,283	→	3
810411	Unwrought magnesium, containing ≧ 99.8 % by weight of magnesium	–0.31	–0.27	→	9,756	9,704	→	3
810419	Unwrought magnesium, containing < 99.8 % by weight of magnesium	–0.16	–0.17	→	7,518	8,219	↗	3
810420[1)]	Magnesium waste and scrap (excl. ash and residues containing magnesium, and raspings, turnings and granules graded according to size)	1.00	1.15	↘	991	2,214	↑	1
810430[1)]	Magnesium raspings, turnings and granules; magnesium powders	–0.31	–0.27	→	9,966	9,538	↘	3
810490[1)]	Articles of magnesium (n. e. s.)	–0.16	–0.16	→	6,172	7,399	↑	3
Manganese	Mining output	0.11	0.08	→	1,567	1,913	↗	2
	Ferromanganese output	0.21	0.17	→	1,746	2,019	↗	2
	Ferromanganese + ferrosilico-manganese output	–0.08	–0.10	→	3,434	4,755	↑	3
260200[1)]	Manganese ores and concentrates, incl. ferruginous manganese ores and concentrates, with a manganese content of ≧ 20 %, calculated on the dry weight	0.17	0.12	→	2,839	2,884	→	3
282010[1)]	Manganese oxides (manganese dioxide)	–0.12	–0.09	→	1,866	1,715	→	2
282090	Manganese oxides (excl. manganese dioxide)	0.58	0.36	↑	1,770	2,140	↗	2
720211	Ferromanganese, containing by weight > 2 % of carbon	0.16	0.08	→	2,350	2,166	→	2

Table 3 (contd.): Changes in risk of all raw materials analysed and their commodities

Raw material / HS code	Specification	WCR			HHI			RG
		2018	2020	Change	2018	2020	Change	2020
720219[1)]	Ferromanganese, containing by weight ≦ 2 % of carbon	1.15	1.07	→	3,286	2,951	↘	2
720230	Ferrosilicomanganese	0.10	0.15	→	1,806	1,858	→	2
811100	Manganese and articles thereof, n. e. s.; manganese waste and scrap (excl. ash and residues containing manganese)	–0.27	–0.21	→	8,297	7,646	↘	3
Molybdenum	Mining output	0.26	0.14	↘	2,299	2,300	→	2
	Ferromolybdenum output	–0.15	–0.13	→	6,597	6,763	→	3
261310	Molybdenum ores and concentrates (roasted)	0.89	0.74	↘	3,221	3,327	→	2
261390	Molybdenum ores and concentrates (excl. roasted)	0.16	0.15	→	3,447	3,075	↘	3
282570	Molybdenum oxides and hydroxides	0.66	0.49	↘	2,282	2,685	↗	3
284170[1)]	Molybdates	0.26	–0.55	↓	1,667	7,176	↑	3
720270	Ferromolybdenum	0.90	0.84	→	1,587	2,095	↗	1
810210[1)]	Molybdenum powders	0.91	0.66	↓	4,317	4,716	↗	2
810294	Unwrought molybdenum, incl. bars (rods) obtained simply by sintering	–0.18	–0.20	→	6,692	5,497	↓	3
810297	Molybdenum waste and scrap (excl. ash and residues containing molybdenum)	0.43	0.10	↓	1,674	2,517	↗	3
Nickel	Mining output	0.03	0.03	→	1,286	1,479	→	1
	Ferronickel output	0.11	0.09	→	1,168	1,061	→	1
	Refinery output	0.25	0.20	→	1,410	1,706	↗	2
260400[1)]	Nickel ores and concentrates	–0.24	–0.26	→	3,960	5,855	↑	3
282540	Nickel oxides and hydroxides	0.29	0.32	→	3,138	2,164	↘	2
282735[1)]	Nickel chloride	1.02	0.91	↘	4,956	4,702	↘	2
283324[1)]	Sulphates; of nickel	1.24	1.25	→	2,889	2,326	↘	1
720260[1)]	Ferronickel	–0.10	–0.08	→	2,460	5,206	↑	3
750110[1)]	Nickel mattes	0.44	0.32	↘	2,837	2,861	→	3
750120[1)]	Nickel oxide sinters and other intermediate products of nickel metallurgy (excl. nickel mattes)	–0.32	–0.17	↘	2,828	2,357	↘	2
750210	Nickel; unwrought, not alloyed	0.78	0.80	→	1,534	2,125	↗	1
750220	Nickel; unwrought, alloys	0.38	0.75	↓	3,915	2,650	↓	2

Table 3 (contd.): Changes in risk of all raw materials analysed and their commodities

Raw material / HS code	Specification	WCR			HHI			RG
		2018	2020	Change	2018	2020	Change	2020
750300	Waste and scrap, of nickel (excl. ingots or other similar unwrought shapes, of remelted nickel waste and scrap, ashes and residues containing nickel)	0.15	0.56	↑	1,589	4,024	↑	2
750400[1)]	Powders and flakes, of nickel (excl. nickel oxide sinters)	1.40	1.26	↗	2,711	2,841	→	2
Niobium	Mining output	–0.11	–0.07	→	7,825	7,837	→	3
	Ferroniobium output	–0.06	–0.05	→	7,950	8,169	↗	3
720293	Ferroniobium	–0.08	–0.02	→	8,160	7,964	→	3
Palladium	Mining output	–0.08	–0.18	→	3,149	3,288	→	3
711021[1)]	Palladium, unwrought or in powder form	–0.03	–0.19	↗	3,412	2,355	↑	2
Perlite	Mining output	–0.01	–0.04	→	2,055	2,291	↗	2
Phosphate	Mining output	–0.14	–0.16	→	2,178	2,057	→	2
251010	Natural calcium phosphates and natural aluminium calcium phosphates, natural and phosphatic chalk (unground)	–0.35	–0.25	→	3,820	3,400	↘	3
251020[1)]	Natural calcium phosphates and natural aluminium calcium phosphates, natural and phosphatic chalk (unground)	–0.36	–0.34	→	2,721	2,817	→	3
280920[1)]	Phosphoric acid; polyphosphoric acids, whether or not chemically defined	–0.10	–0.17	→	2,139	2,462	↗	2
310530	Diammonium phosphate	–0.27	–0.24	→	3,885	3,309	↘	3
310540	Monoammonium phosphate and mixtures thereof with diammonium	–0.26	–0.20	→	2,531	2,331	→	2
Platinum	Mining output	–0.01	–0.07	→	5,349	5,024	↘	3
711011[1)]	Platinum, unwrought or in powder form	0.17	0.33	↘	3,854	2,787	↑	3
711292[1)]	Waste and scrap of platinum (incl. metal clad with platinum, and other waste and scrap containing platinum or platinum compounds)	1.07	–0.44	→	1,151	9,884	→	3
711510	Catalysts in the form of wire cloth or grill, of platinum	1.45	0.98	↑	3,876	1,909	↑	1
Pyrophyllite	Mining output	0.22	0.43	↑	2,503	1,927	↘	2

Table 3 (contd.): Changes in risk of all raw materials analysed and their commodities

Raw material / HS code	Specification	WCR			HHI			RG
		2018	2020	Change	2018	2020	Change	2020
Mercury	Mining output	–0.33	–0.30	→	6,029	7,385	↑	3
280540[1)]	Mercury	0.04	–0.10	↘	2,169	1,286	↓	1
Rhenium	Refinery output (by-products)	0.62	0.60	→	2,738	3,148	↗	2
Rhodium	Mining output	–0.10	–0.10	→	6,786	6,353	↓	3
711031[1)]	Rhodium, unwrought or in powder form	0.57	0.34	↑	3,515	4,636	↑	3
Ruthenium	Mining output	–0.01	–0.01	→	8,113	8,588	↗	3
Selenium	Refinery output (by-products)	0.57	0.48	→	1,506	1,764	↗	2
280490[1)]	Selenium	1.06	1.02	→	1,873	1,844	→	1
Rare earths	Mining output	–0.05	0.00	→	4,788	4,332	↓	3
	Refinery output	–0.21	–0.20	→	7,625	8,380	↗	3
280530[1)]	Rare-earth metals, scandium and yttrium, whether or not intermixed or interalloyed	1.05	1.00	→	5,755	5,549	↓	2
284610[1)]	Cerium compounds	0.23	0.31	→	3,322	2,895	↓	3
284690	Compounds, inorganic or organic, of rare-earth metals, of yttrium or of scandium or of mixtures of these metals (excl. cerium)	0.67	0.76	→	3,645	4,736	↑	2
Silver	Mining output	0.00	0.00	→	1,096	1,019	→	1
261610[1)]	Silver ores and concentrates	–0.24	–0.12	↘	3,255	1,980	↕	2
284321	Silver nitrate	1.18	0.55	↑	3,267	3,753	↗	2
710610	Powder of silver (incl. silver plated with gold or platinum)	1.31	–0.35	↑	7,803	8,922	↑	3
710691	Silver, incl. silver plated with gold or platinum, unwrought (excl. silver in powder form)	0.33	–0.44	↑	1,289	9,888	↑	3
Silicon	Refinery output	0.00	0.03	→	5,136	5,346	↗	3
280461[1)]	Silicon containing ≧ 99.99 % by weight of silicon	1.22	1.07	↗	3,229	3,344	→	2
280469	Silicon containing < 99.99 % by weight of silicon	0.00	0.21	↕	4.258	3.841	↓	3
281122[1)]	Silicon dioxide	0.17	0.25	→	4,720	4,525	→	3
284920	Carbides of silicon, whether or not chemically defined	–0.09	–0.01	→	3,931	3,393	↓	3
720221[1)]	Ferrosilicon, containing by weight > 55 % of silicon	0.00	0.20	↕	1,913	1,247	↓	1

Table 3 (contd.): Changes in risk of all raw materials analysed and their commodities

Raw material / HS code	Specification	WCR			HHI			RG
		2018	2020	Change	2018	2020	Change	2020
720229[1)]	Ferrosilicon, containing by weight ≦ 55 % of silicon	0.86	0.94	→	1,868	2,109	↗	1
Halite	Mining output	0.35	0.29	→	919	963	→	1
250100[1)]	Salts, (incl. table salt and denatured salt) and pure sodium chloride, whether or not in aqueous solution or containing added anti-caking or free-flowing agents)	0.44	0.43	→	1,380	1,626	↗	2
Strontium minerals	Mining output	–0.20	–0.44	↑	2,772	3,028	↗	3
283692[1)]	Strontium carbonate	0.88	0.82	→	5,639	5,472	→	2
Talcum	Mining output	0.26	0.13	↗	1,447	1,482	→	1
252610[1)]	Natural steatite, (not crushed or powdered), whether or not roughly trimmed or merely cut, by sawing or otherwise, into blocks or slabs of a square or rectangular shape	–0.42	0.01	↓	2,747	2,196	↘	2
252620	Natural steatite, (crushed or powdered), whether or not roughly trimmed or merely cut, by sawing or otherwise, into blocks or slabs of a square or rectangular shape	0.01	0.00	→	2.284	2.143	→	2
Tantalum	Mining output	–0.66	–0.77	↗	1,680	1,936	↗	3
810320[1)]	Unwrought tantalum, incl. bars and rods of tantalum obtained simply by sintering; tantalum powders	0.25	0.35	→	2,710	2,847	→	3
810330	Tantalum waste and scrap (excl. ash and residues containing tantalum)	0.41	0.42	→	1,831	2,059	↗	2
810390	Articles of tantalum (n. e. s.)	–0.19	0.16	↓	7,965	2,615	↓	3
Tellurium	Boron; tellurium (tellurium)	1.14	1.12	→	3,013	3,820	↗	2
Titanium	Mining output	0.15	0.36	↓	855	1,113	↗	1
	Refinery output	0.08	0.05	→	2,657	3,635	↗	3
261400[1)]	Titanium ores and concentrates	–0.05	–0.12	→	1,349	1,347	→	1
282300	Titanium oxides	0.67	0.25	↑	1,893	3,230	↑	3
720291	Ferrotitanium and ferrosilicotitanium	0.34	0.12	↑	3,094	3,021	→	3

Table 3 (contd.): Changes in risk of all raw materials analysed and their commodities

Raw material / HS code	Specification	WCR			HHI			RG
		2018	2020	Change	2018	2020	Change	2020
810820	Unwrought titanium; titanium powders	0.55	0.49	→	3,734	3,056	↘	3
810830	Titanium waste and scrap (excl. ash and residues containing titanium)	1.04	1.01	→	1,060	1,511	↗	1
Vanadium	Mining output	–0.34	–0.31	→	4,819	4,785	→	3
282530	Vanadium oxides and hydroxides	–0.24	–0.26	→	2,285	3,267	↗	3
720292	Ferrovanadium	1.12	0.98	↗	2,395	2,382	→	1
811292[1,2)]	Unwrought hafnium, niobium (columbium), rhenium, gallium, indium, vanadium and germanium; powders and waste and scrap of these metals (excl. ash and residues) (vanadium)	1.21	0.69	↑	5,737	5,733	→	2
Vermiculite	Mining output	0.08	0.08	→	2,005	2,082	→	2
Bismuth	Refinery output	–0.28	–0.18	↘	5,862	7,221	↑	3
810600[1)]	Bismuth and articles thereof, n. e. s.; bismuth waste and scrap (excl. ash and residues containing bismuth)	–0.12	–0.15	→	5,268	5,899	↗	3
Tungsten	Mining output	–0.29	–0.27	→	6,321	7,328	↑	3
261100[1)]	Tungsten ores and concentrates	–0.22	0.15	↓	1,129	914	↘	1
282590[1,2)]	Bases, inorganic, and metal oxides, hydroxides and peroxides, n. e. s. (tungsten oxides & hydroxides)	–0.21	–0.09	↘	6,062	5,121	↘	3
284180[1)]	Tungstates (wolframates)	–0.30	0.26	↓	4,960	2,997	↓	3
284990[1,2)]	Carbides, whether or not chemically defined (excl. of calcium or silicon) (tungsten carbide)	0.46	0.53	→	4,394	3,916	↘	2
720280	Ferrotungsten and ferrosilicotungsten	–0.12	–0.43	↓	3,934	4,273	↗	3
810110[1)]	Tungsten powders	0.31	0.43	↘	4,060	3,008	↓	3
810194[1)]	Unwrought tungsten, incl. bars and rods of tungsten obtained simply by sintering	–0.18	0.20	↓	8,221	4,370	↓	3
810197[1)]	Tungsten waste and scrap (excl. ash and residues containing tungsten)	0.65	0.85	↘	811	1,183	↗	1
Wollastonite	Mining output	–0.18	–0.17	→	4,892	5,561	↗	3
Zeolite	Mining output	0.39	0.43	→	1,023	1,050	→	1

Table 3 (contd.): Changes in risk of all raw materials analysed and their commodities

Raw material / HS code	Specification	WCR			HHI			RG
		2018	2020	Change	2018	2020	Change	2020
Zinc	Mining output	0.07	0.08	→	1,503	1,511	→	2
	Refinery output	0.27	0.25	→	2,029	2,297	↗	2
260800	Zinc ores and concentrates	0.31	0.32	→	1,216	1,233	→	1
262011[1)]	Hard zinc spelter	1.10	1.13	→	1,176	1,489	↗	1
262019[1)]	Slag, ash and residues containing mainly zinc (excl. hard zinc spelter)	1.13	1.01	↗	2,175	2,310	→	1
281700	Zinc oxide; zinc peroxide	0.53	0.66	↘	826	998	→	1
790111	Unwrought zinc, not alloyed, containing by weight ≧ 99.99 % of zinc	1.02	0.88	↗	1,069	876	→	1
790112	Unwrought zinc, not alloyed, containing by weight < 99.99 % of zinc	0.37	0.50	↘	1,059	1,177	→	1
790120[1)]	Unwrought zinc alloys	1.22	1.21	→	1,499	1,406	→	1
790200[1)]	Zinc waste and scrap (excl. ash and residues from zinc production [heading 2620], ingots and other similar unwrought shapes)	0.82	0.82	→	730	905	→	1
790310	Zinc dust	0.87	0.37	↑	2,063	1,665	↘	2
790390	Zinc powders and flakes (excl. grains of zinc, and spangles of heading 8308, and zinc dust)	0.44	1.08	↑	1,784	2,298	↗	1
Tin	Mining output	–0.38	–0.35	→	1,897	1,883	→	2
	Refinery output	–0.10	–0.08	→	2,663	2,823	→	3
260900[1)]	Tin ores and concentrates	–0.78	–0.73	→	7,846	6,534	↓	3
262099[1,2)]	Slag, ash and residues, containing metals or metal compounds (excl. those from the manufacture of iron or steel, those containing mainly zinc, lead, copper, aluminium, arsenic, mercury, thallium, antimony, beryllium, cadmium or chromium) (tin ash)	1.19	1.14	→	3,035	3,026	→	2
800110	Unwrought tin, not alloyed	0.02	0.10	→	2,603	2,523	→	3
800120[1)]	Tin alloys	0.88	0.57	↑	1,989	1,308	↘	1
800200	Tin waste and scrap (excl. ash and residues from the manufacture of tin [heading 2620], and ingots and similar unwrought shapes)	1.31	1.35	→	5,105	5,307	↗	2
Zirconium	Mining output	0.39	0.48	→	1,964	2,152	→	2
261510[1)]	Zirconium ores and concentrates	0.60	0.82	↑	2,549	3,982	↑	2

Table 3 (contd.): Changes in risk of all raw materials analysed and their commodities

Raw material / HS code	Specification	WCR			HHI			RG
		2018	2020	Change	2018	2020	Change	2020
810920[1)]	Unwrought zirconium; zirconium powders	0.54	0.21	↑	3,991	3,632	↘	3
810930[1)]	Zirconium waste and scrap (excl. ash and residues containing zirconium)	1.12	1.20	→	1,601	2,114	↗	1

RG: Risk group

Change: ↑ Risk has increased, ↓ Risk has declined

[1)] Net exports of important supplier countries partly derived from “reverse trade” (global imports from a specific country).
[2)] Net exports determined on the basis of extended HS codes at country level.

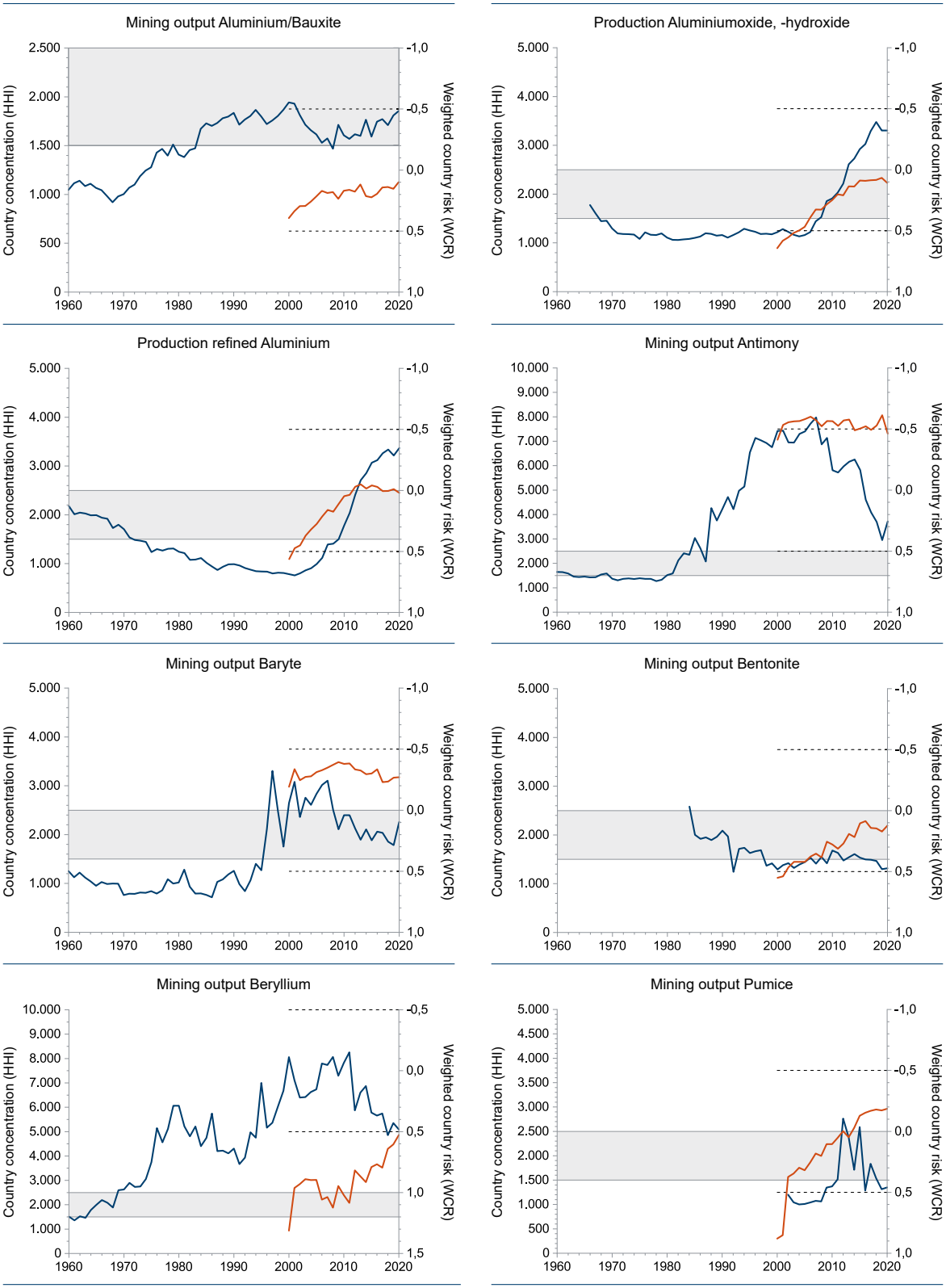


Fig. 9: Long-term trends in country concentration (HHI) and weighted country risk (WCR)

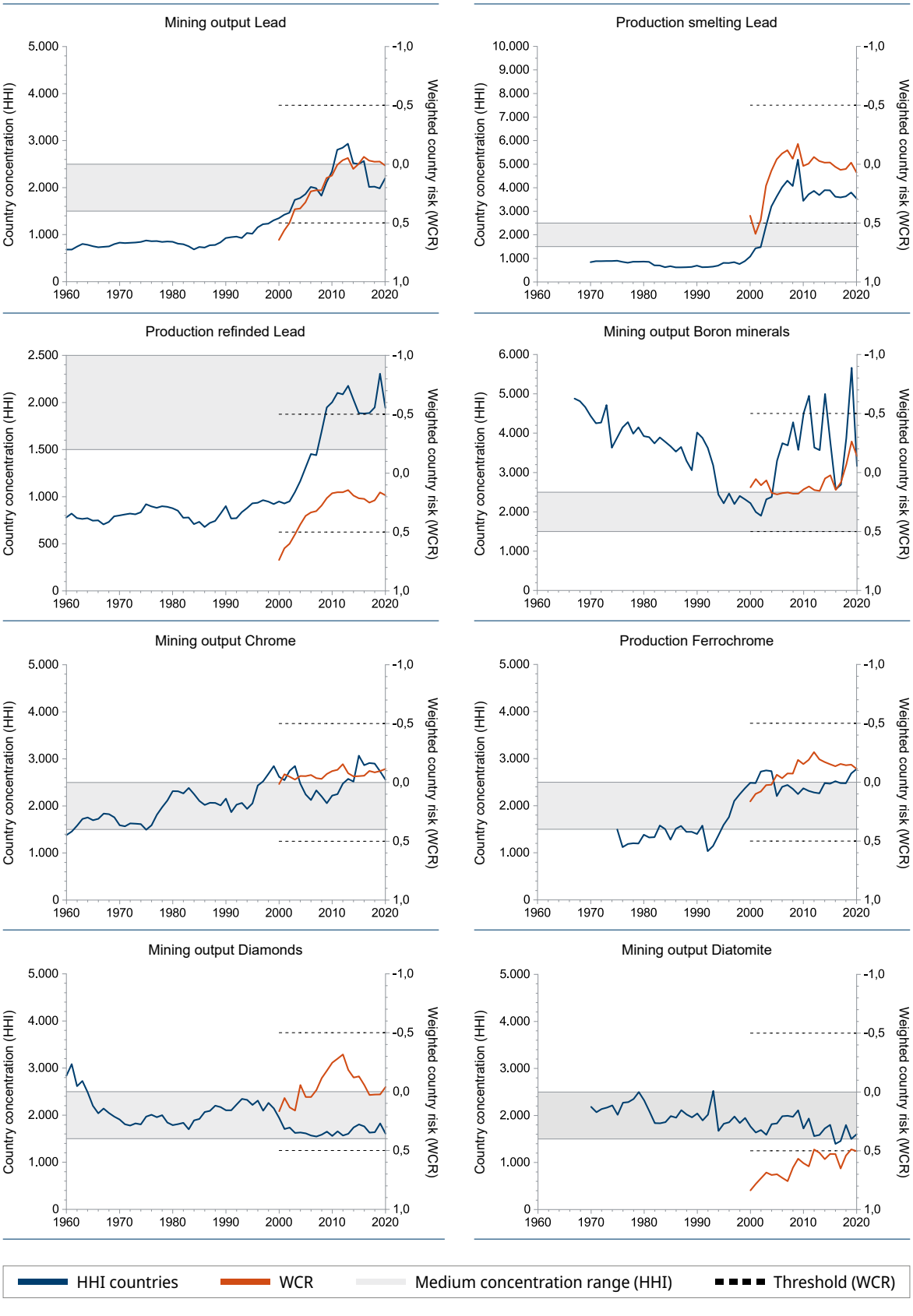


Fig. 9 (contd.): Long-term trends in country concentration (HHI) and weighted country risk (WCR)

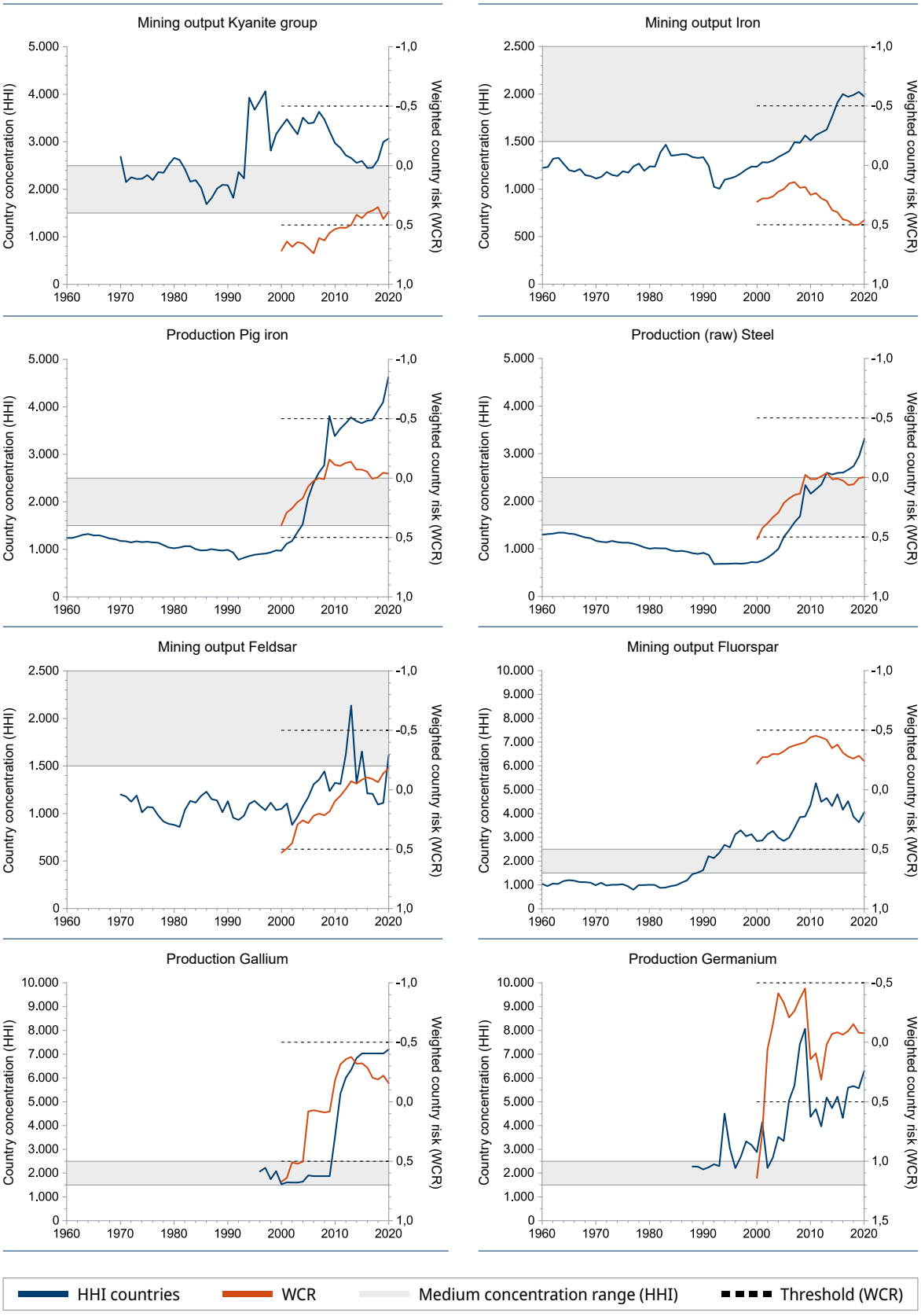


Fig. 9 (contd.): Long-term trends in country concentration (HHI) and weighted country risk (WCR)

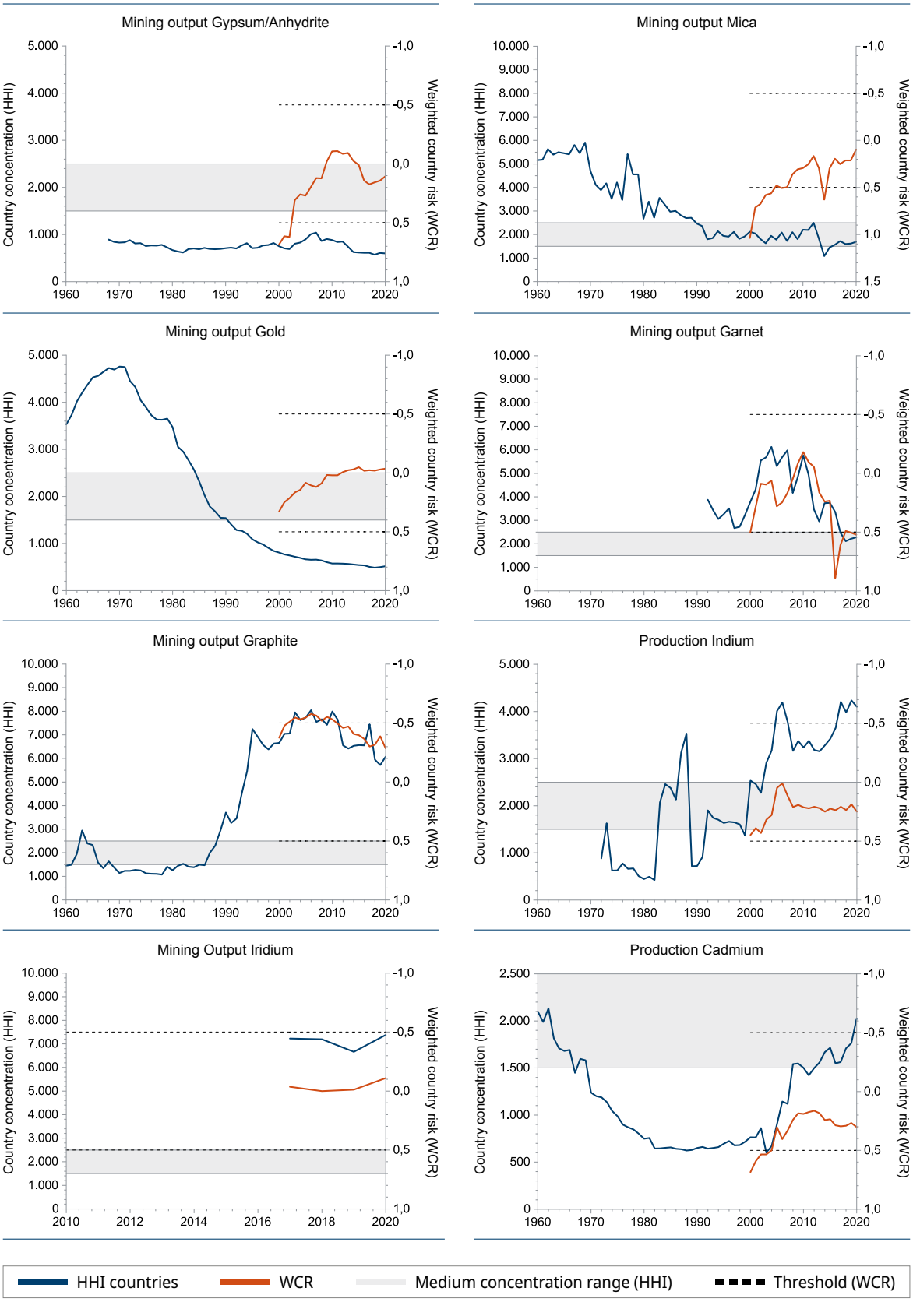


Fig. 9 (contd.): Long-term trends in country concentration (HHI) and weighted country risk (WCR)

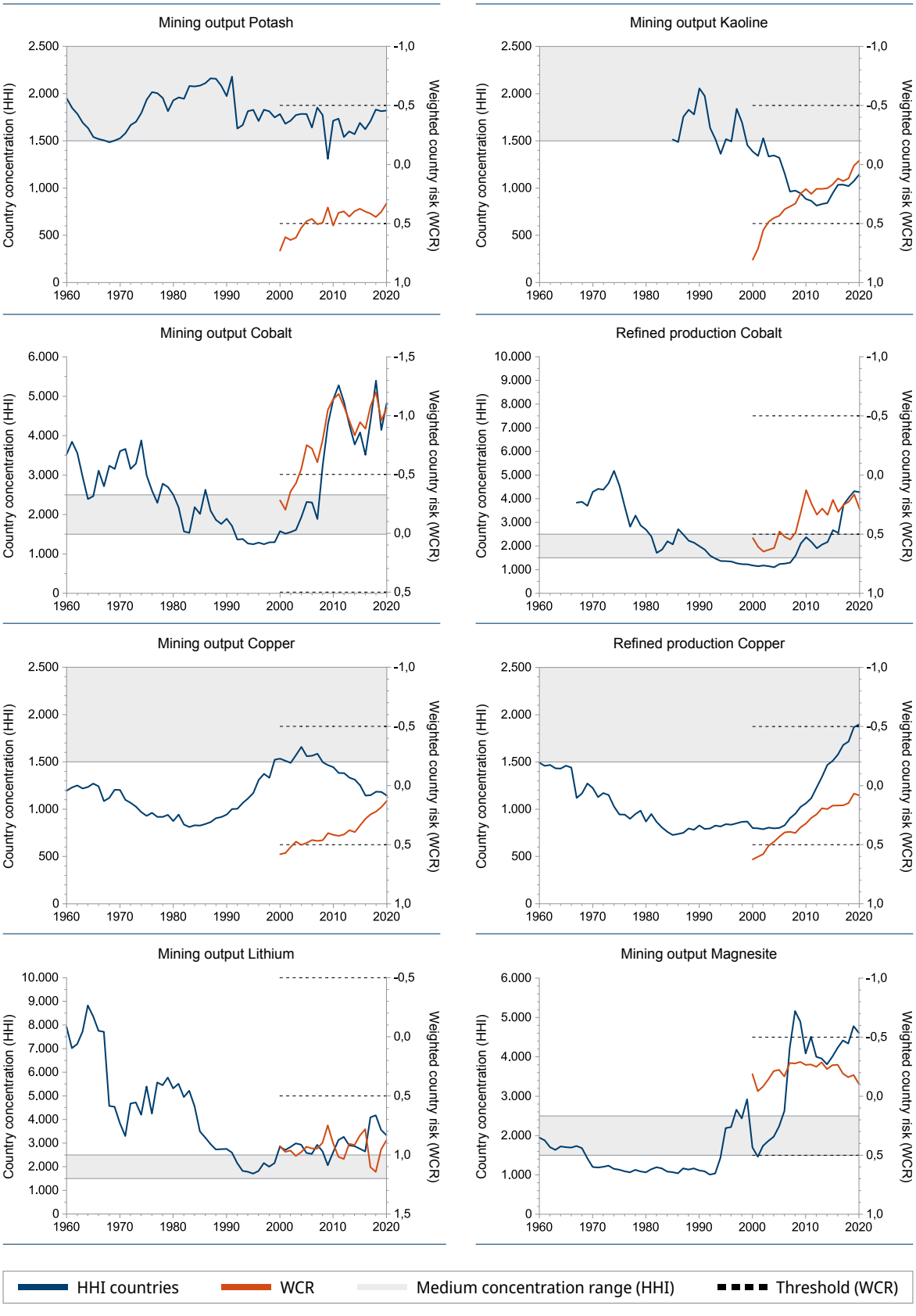


Fig. 9 (contd.): Long-term trends in country concentration (HHI) and weighted country risk (WCR)

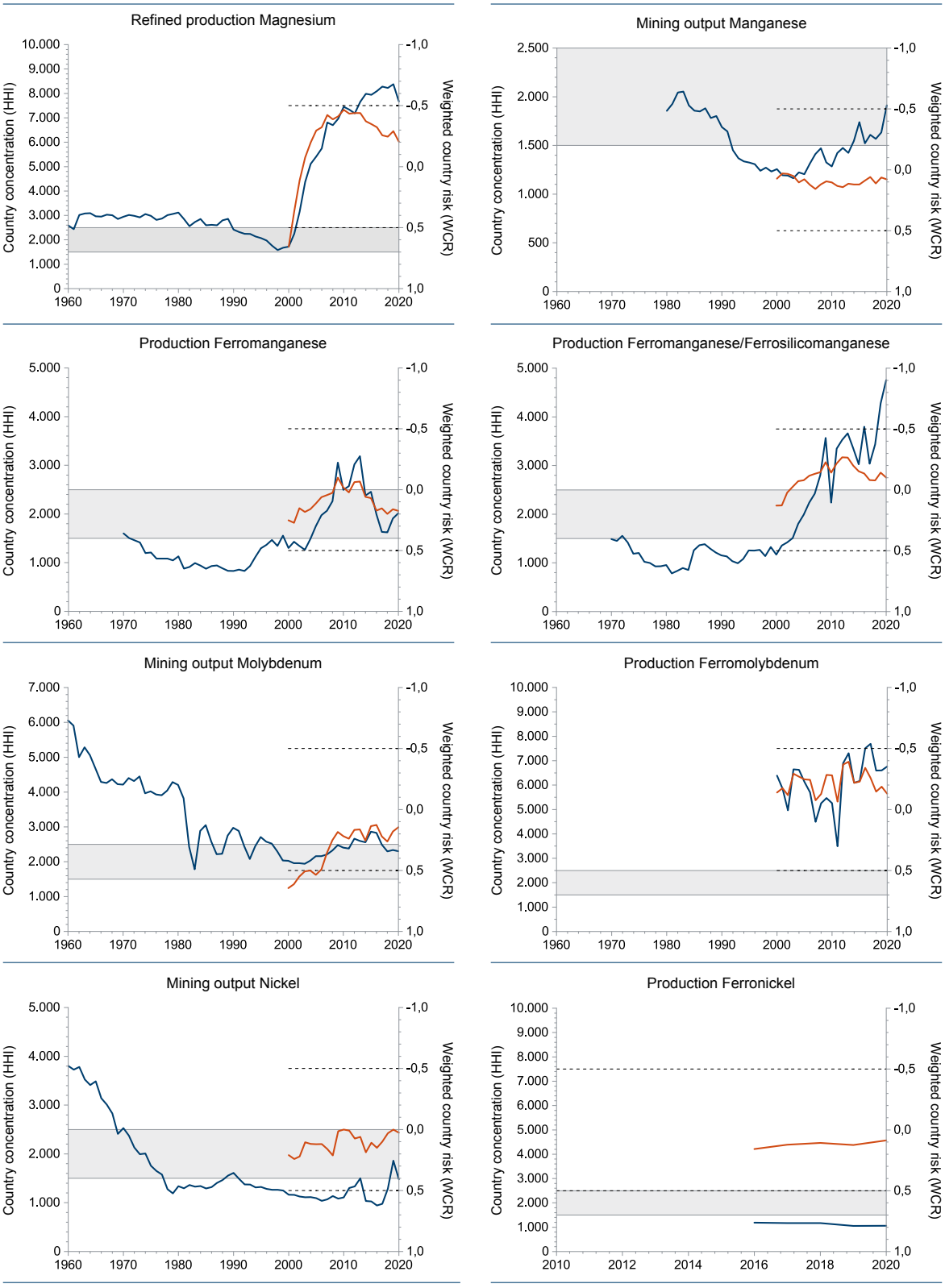


Fig. 9 (contd.): Long-term trends in country concentration (HHI) and weighted country risk (WCR)

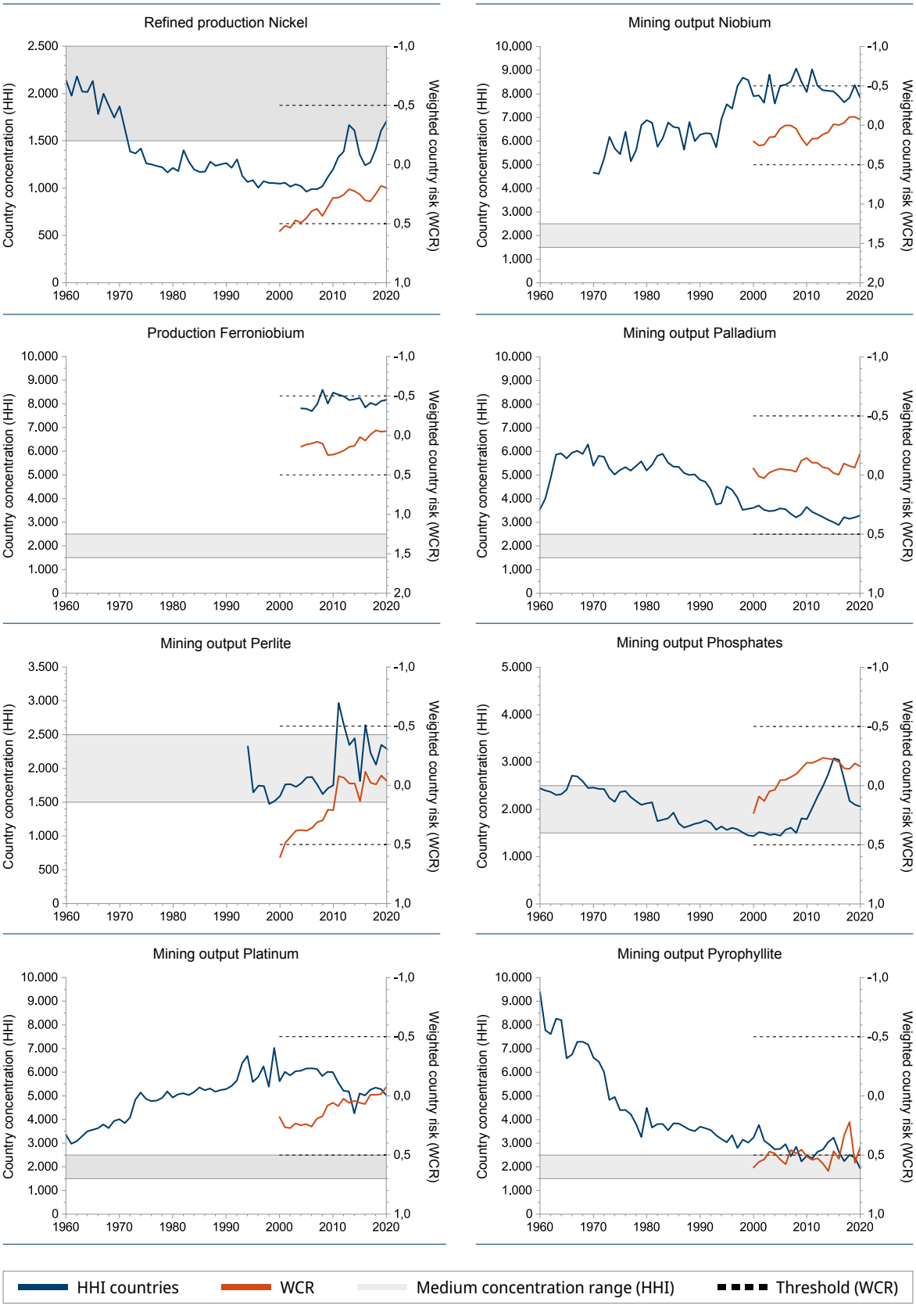


Fig. 9 (contd.): Long-term trends in country concentration (HHI) and weighted country risk (WCR)

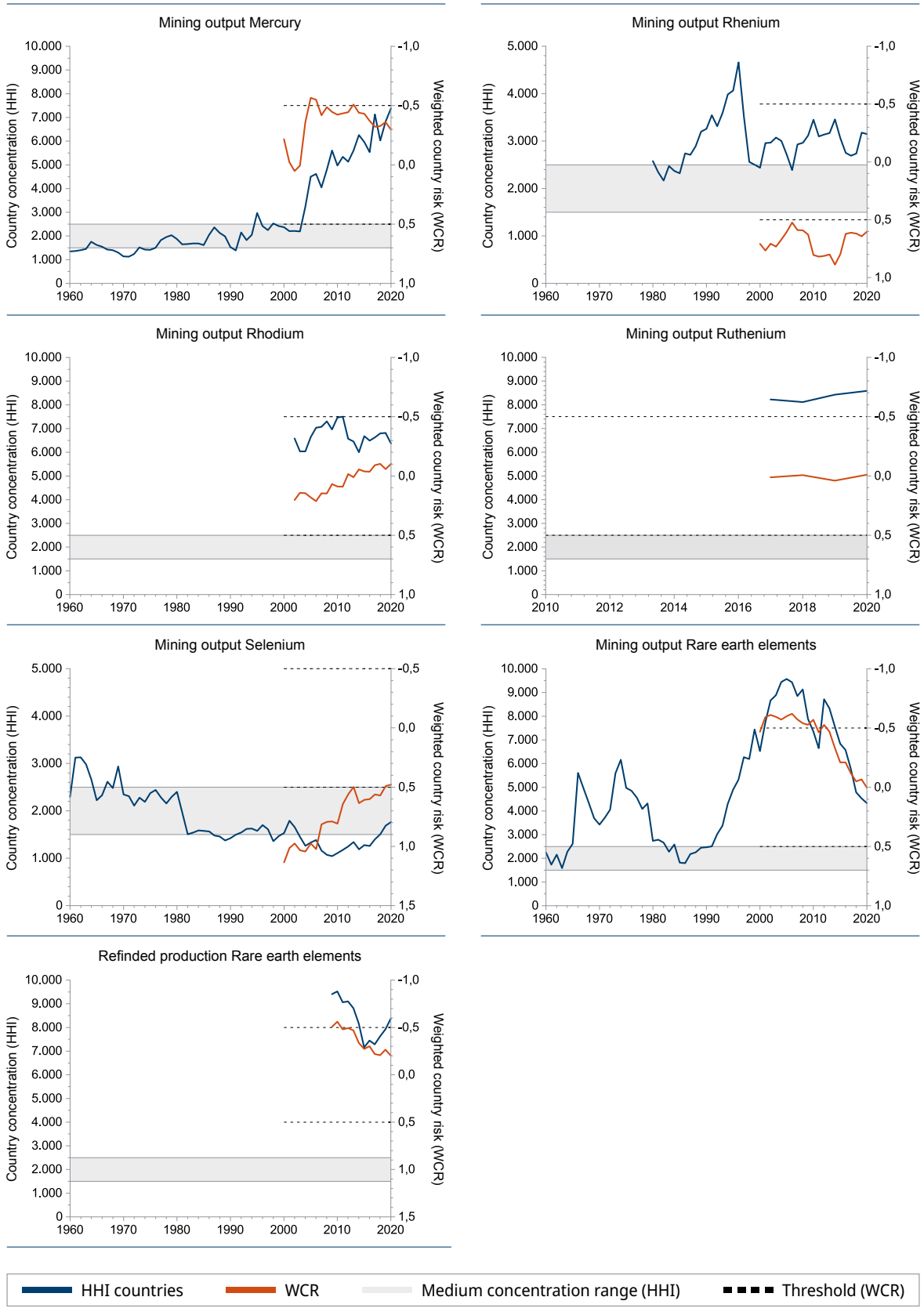


Fig. 9 (contd.): Long-term trends in country concentration (HHI) and weighted country risk (WCR)

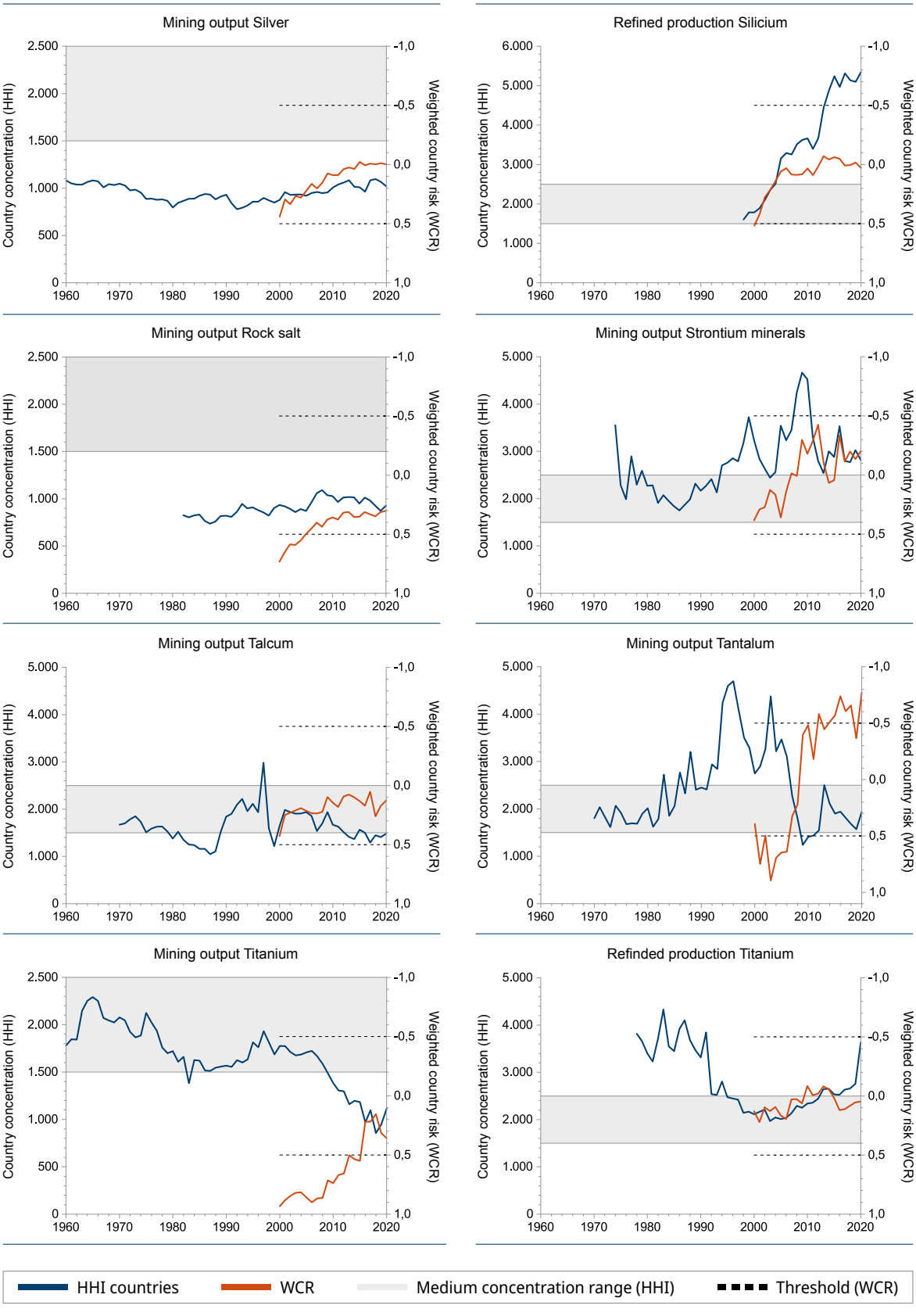


Fig. 9 (contd.): Long-term trends in country concentration (HHI) and weighted country risk (WCR)

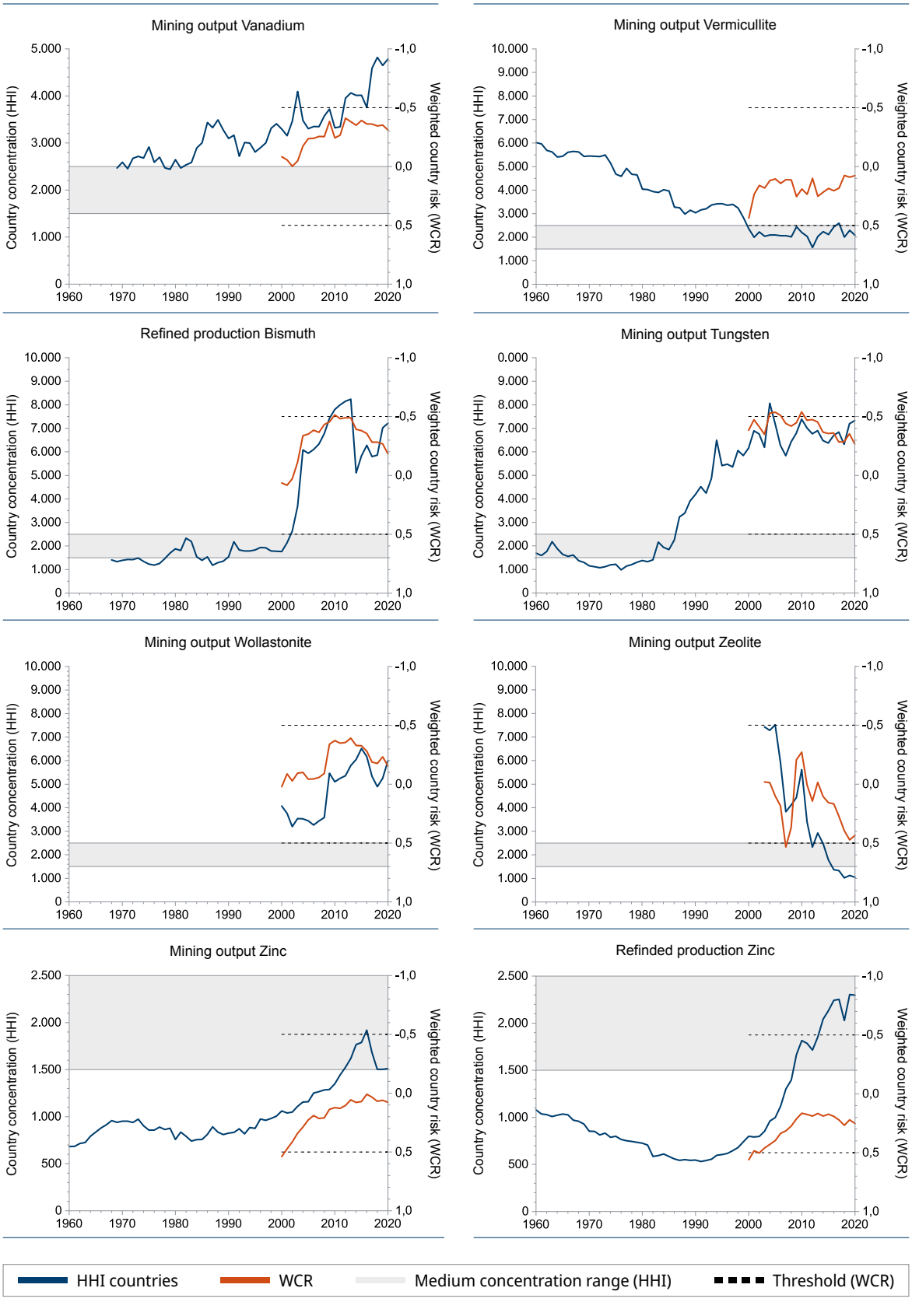


Fig. 9 (contd.): Long-term trends in country concentration (HHI) and weighted country risk (WCR)

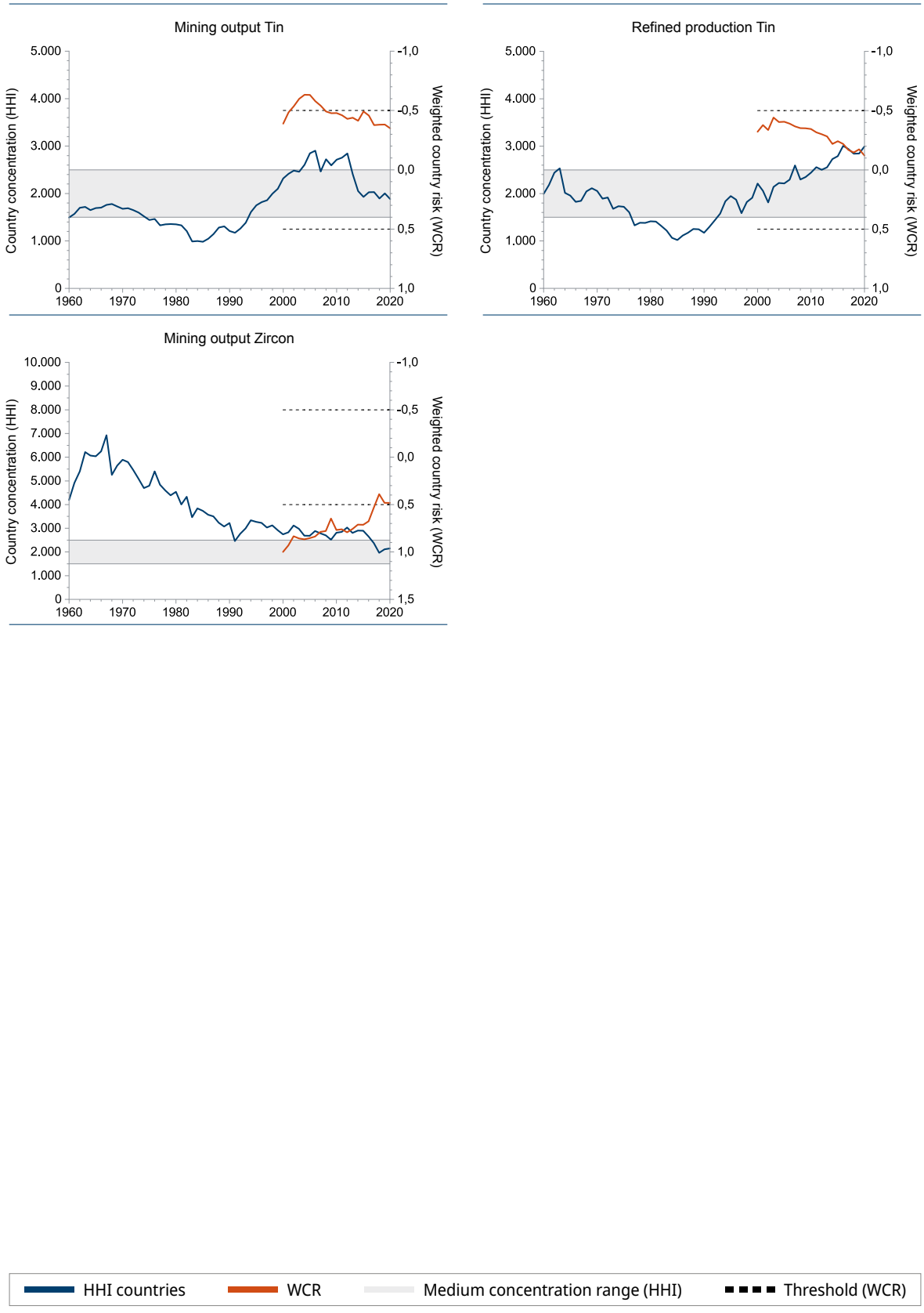


Fig. 9 (contd.): Long-term trends in country concentration (HHI) and weighted country risk (WCR)

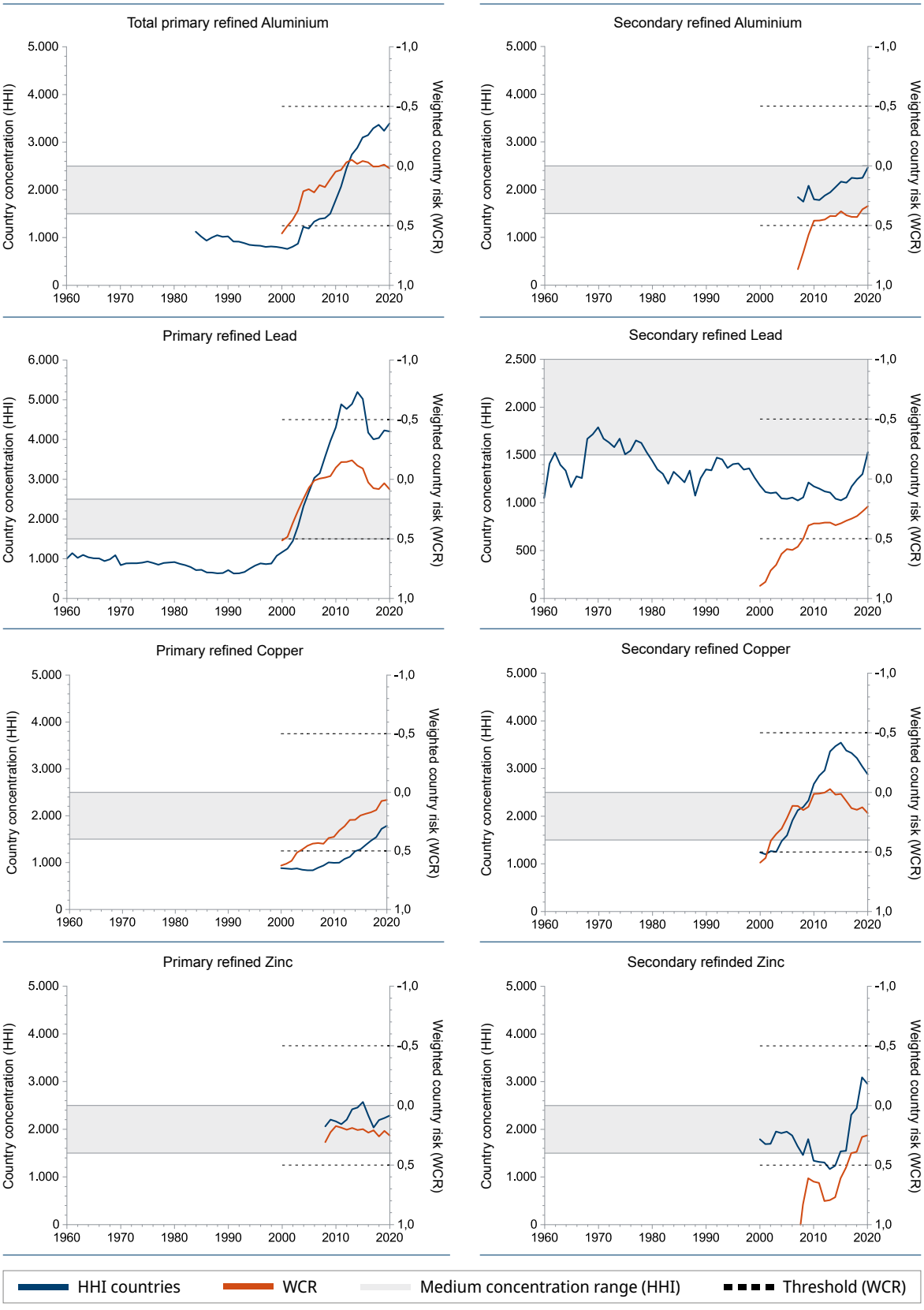


Fig. 10: Long-term trends in country concentration (HHI) and weighted country risk (WCR) for refinery output from primary and secondary aluminium, lead, copper and zinc raw materials

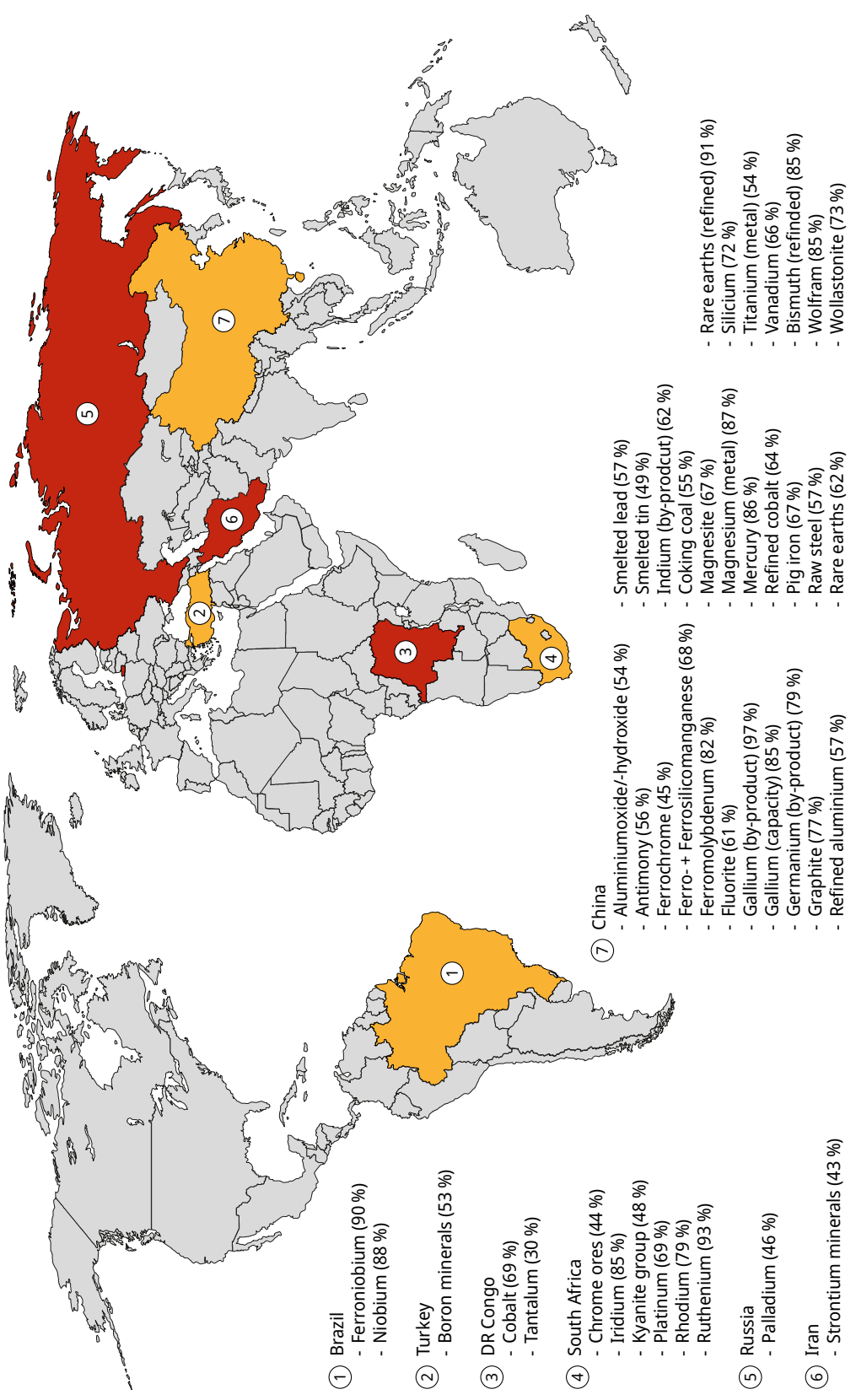


Fig. 11: Main producers of mining and refinery products from raw materials in risk group 3

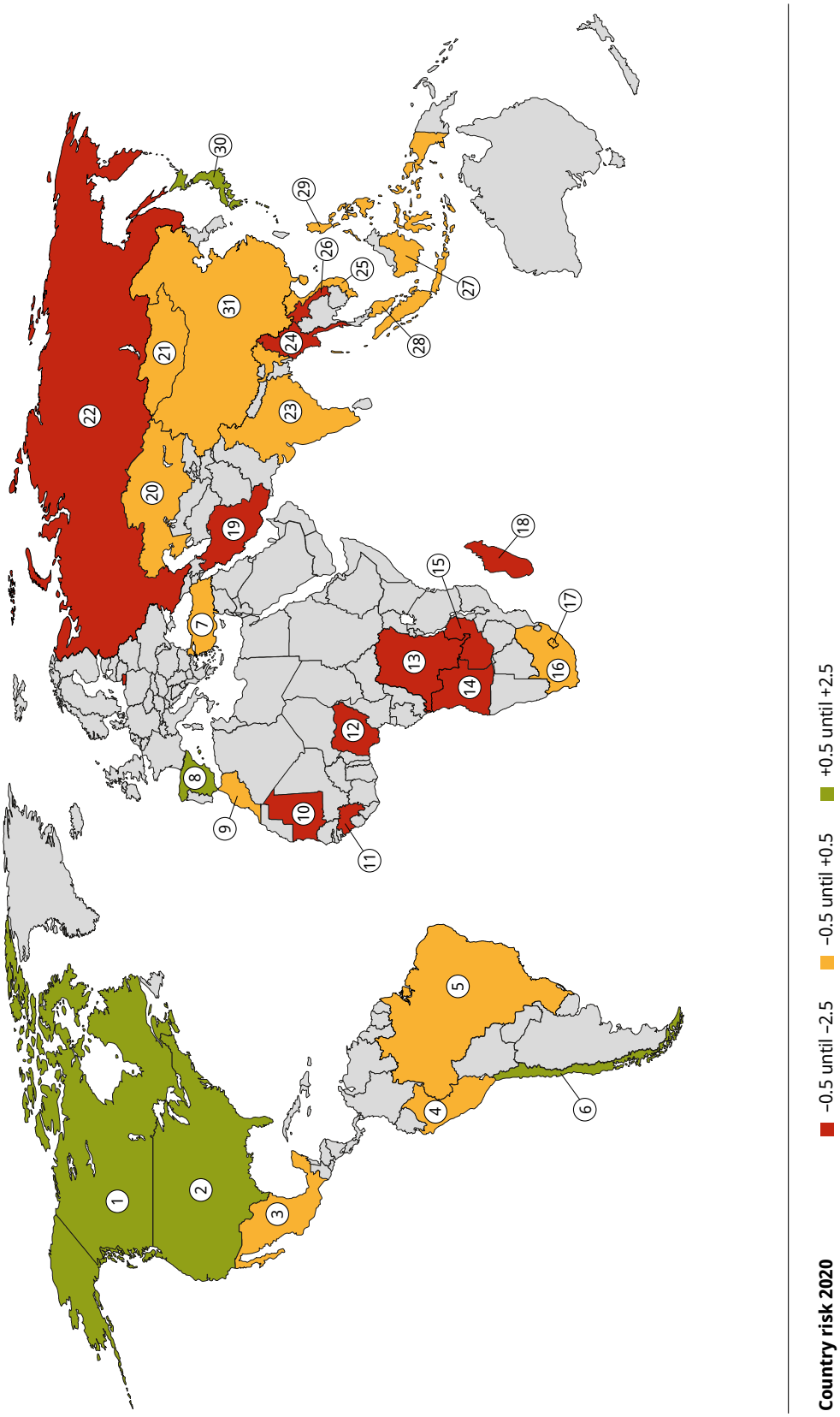


Fig. 12: Main net exporters of products in risk group 3

① Canada
- Ni3: HS 750110 (35 %)

② USA
- Ba1: HS 251120 (61 %)
- Co2: HS 282200 (45 %)
- Fe8: HS 720390 (53 %)

③ Mexico
- Ag1: HS 710610 (94 %)
- Ag2: HS 710691 (99 %)
- Au2: HS 710812 (79 %)
- F2: HS 252922 (49 %)

④ Peru
- Mo1: HS 261390 (49 %)

⑤ Brazil
- Fe1: HS 260120 (64 %)
- Mo5: HS 810297 (37 %)
- Nb: HS 720293 (89 %)
- V: HS 282530 (41 %)

⑥ Chile
- Mo2: HS 282570 (44 %)

⑦ Turkey
- B1: HS 281000 (39 %)
- B2: HS 284019 (65 %)
- B3: HS 284020 (51 %)
- Cr2: HS 281910 (32 %)
- Feld: HS 252910 (66 %)

⑧ Spain
- Au1: HS 284330 (61 %)

⑨ Marocco
- P1: HS 251010 (51 %)
- P2: HS 251020 (48 %)

⑩ Mauretania
- Fe3: HS 282110 (60 %)

⑪ Guinea
- Al1: HS 260600 (53 %)

⑫ Nigeria
- Be: HS 811212 (86 %)
- Cu2: HS 740312 (85 %)

⑬ DR Congo
- Co1: HS 260500 (99 %)
- Co3: HS 810520 (89 %)
- Co4: HS 810590 (93 %)
- Cu3: HS 740319 (50 %)

⑭ Angola
- Dia1: HS 710221 (99 %)

⑮ Zambia
- Cu1: HS 740200 (45 %)

⑯ South Africa
- Cr1: HS 261000 (83 %)
- Cr4: HS 720241 (51 %)
- Kya: HS 250850 (50 %)
- Mn1: HS 260200 (47 %)
- Pt1: HS 711011 (42 %)
- Pt2: HS 711292 (99 %)
- Rh: HS 711031 (66 %)
- Zr: HS 810920 (49 %)

⑰ Lesotho
- Dia2: HS 710231 (90 %)

⑱ Madagascar
- Mica3: HS 252530 (52 %)

⑲ Iran
- Fe10: HS 720610 (98 %)

⑳ Kazakhstan
- Cr3: HS 281990 (61 %)
- Cr5: HS 720250 (58 %)
- Fe5: HS 720120 (75 %)

㉑ Mongolia
- F1: HS 252921 (54 %)

㉒ Russia
- Cr6: HS 811221 (58 %)
- Fe4: HS 720110 (31 %)
- Fe6: HS 720150 (41 %)
- Ti2: HS 720291 (45 %)
- W3: HS 720280 (47 %)

㉓ India
- Fe9: HS 720510 (64 %)
- Mica1: HS 252510 (59 %)
- Pb: HS 282490 (57 %)

㉔ Myanmar
- Sn1: HS 260900 (80 %)

㉕ Viet Nam
- W2: HS 284180 (40 %)

㉖ Laos
- Mo3: HS 284170 (84 %)

㉗ Indonesia
- Ni2: HS 720260 (71 %)
- Sn2: HS 800110 (45 %)

㉘ Malaysia
- Cu4: HS 740329 (50 %)
- Cu5: HS 740610 (72 %)
- Cu6: HS 740620 (94 %)
- Fe2: HS 261800 (67 %)
- REE: HS 284610 (35 %)

㉙ Philippines
- Ni1: HS 260400 (74 %)

㉚ Japan
- Ti3: HS 810820 (47 %)

㉛ China
- Al2: HS 281810 (85 %)
- Ba2: HS 283327 (89 %)
- Bi: HS 810600 (76 %)
- C1: HS 250410 (60 %)
- C2: HS 250490 (93 %)
- C3: HS 380110 (88 %)
- F3: HS 281111 (63 %)
- Fe7: HS 720299 (39 %)
- Ga: HS 811292 (56 %)
- Mica2: HS 252520 (52 %)
- Li: HS 282520 (70 %)
- Mag1: HS 251910 (60 %)
- Mag2: HS 251990 (73 %)
- Mg1: HS 283321 (77 %)
- Mg2: HS 810411 (99 %)
- Mg3: HS 810419 (90 %)
- Mg4: HS 810430 (98 %)
- Mg5: HS 810490 (86 %)
- Mn2: HS 811100 (87 %)
- Mo4: HS 810294 (71 %)
- P3: HS 310530 (40 %)
- Sb: HS 282580 (68 %)
- Si1: HS 280469 (57 %)
- Si2: HS 281122 (66 %)
- Si3: HS 284920 (55 %)
- Ta1: HS 810320 (47 %)
- Ta2: HS 810390 (35 %)
- Ti1: HS 282300 (53 %)
- W1: HS 282590 (69 %)
- W4: HS 810110 (49 %)
- W5: HS 810194 (63 %)

Table 4: 2020 Worldwide Governance Indicators for major countries

Country	Overall index	Voice and Account-ability	Political Stability and Absence of Violence/ Terrorism	Govern-ment Effec-tiveness	Regula-tory Quality	Rule of Law	Control of Corrup-tion
Afghanistan	–1.68	–1.08	–2.71	–1.59	–1.40	–1.82	–1.48
Angola	–0.87	–0.80	–0.51	–1.20	–0.84	–0.91	–0.95
Argentina	–0.14	0.59	–0.08	–0.22	–0.48	–0.47	–0.14
Armenia	–0.14	0.05	–0.76	–0.27	0.25	–0.10	0.02
Australia	1.48	1.30	0.85	1.61	1.82	1.64	1.66
Austria	1.45	1.40	0.91	1.65	1.41	1.80	1.51
Belarus	–0.85	–1.45	–0.90	–0.80	–0.78	–1.05	–0.11
Belgium	1.19	1.28	0.54	1.12	1.35	1.36	1.48
Bolivia	–0.72	–0.08	–0.46	–0.70	–1.02	–1.21	–0.82
Botswana	0.55	0.49	1.03	0.20	0.54	0.41	0.63
Brazil	–0.21	0.30	–0.43	–0.44	–0.10	–0.21	–0.41
Canada	1.50	1.48	1.03	1.64	1.60	1.65	1.59
Chile	0.81	1.00	0.07	0.74	0.96	0.94	1.13
China	–0.27	–1.65	–0.33	0.68	–0.19	–0.08	–0.05
Colombia	–0.16	0.15	–0.66	0.04	0.24	–0.48	–0.23
Congo, DR	–1.60	–1.27	–1.74	–1.71	–1.49	–1.80	–1.57
Czechia	0.96	0.98	0.92	0.95	1.24	1.05	0.58
Egypt	–0.79	–1.48	–1.17	–0.42	–0.56	–0.31	–0.79
Finland	1.78	1.61	1.01	1.94	1.86	2.07	2.20
France	1.05	1.07	0.32	1.24	1.20	1.32	1.15
Gabon	–0.74	–0.98	–0.07	–0.97	–0.87	–0.67	–0.87
Georgia	0.38	0.06	–0.42	0.75	1.01	0.24	0.63
Germany	1.40	1.38	0.68	1.35	1.59	1.55	1.86
Ghana	0.05	0.55	0.18	–0.17	–0.12	–0.05	–0.11
Greece	0.41	0.97	0.13	0.44	0.55	0.32	0.06
Guinea	–0.94	–0.92	–0.67	–0.94	–0.86	–1.27	–0.95
Hong Kong	1.13	0.04	0.09	1.65	1.79	1.58	1.65
Hungary	0.48	0.39	0.84	0.57	0.48	0.51	0.09
India	–0.11	0.15	–0.81	0.41	–0.11	–0.03	–0.27
Indonesia	–0.09	0.10	–0.45	0.35	0.23	–0.33	–0.43
Iran	–1.27	–1.48	–1.70	–0.99	–1.47	–0.87	–1.09
Ireland	1.40	1.39	0.98	1.47	1.48	1.49	1.56

Country	Overall index	Voice and Account-ability	Political Stability and Absence of Violence/ Terrorism	Govern-ment Effec-tiveness	Regula-tory Quality	Rule of Law	Control of Corrup-tion
Italy	0.53	1.06	0.43	0.39	0.50	0.24	0.54
Japan	1.33	0.99	1.04	1.59	1.36	1.51	1.49
Jordan	–0.06	–0.75	–0.27	0.13	0.27	0.22	0.06
Kazakhstan	–0.33	–1.18	–0.26	0.14	0.12	–0.44	–0.36
Korea, Rep.	0.95	0.82	0.57	1.41	1.04	1.18	0.72
Laos	–0.77	–1.79	0.68	–0.75	–0.82	–0.86	–1.07
Latvia	0.85	0.87	0.47	0.87	1.19	0.95	0.72
Lesotho	–0.41	–0.01	-0.25	–0.95	–0.65	–0.47	–0.11
Madagascar	–0.74	–0.26	–0.53	–1.03	–0.80	–0.86	–0.99
Malaysia	0.42	-0.15	0.11	1.06	0.68	0.59	0.25
Mauritania	–0.77	–0.83	–0.72	–0.81	–0.88	–0.59	–0.79
Mexico	–0.45	–0.03	–0.86	–0.24	0.00	–0.65	–0.90
Mongolia	–0.01	0.38	0.72	–0.37	–0.06	–0.24	–0.47
Morocco	–0.28	–0.60	–0.35	–0.09	–0.04	–0.19	–0.42
Mozambique	–0.87	–0.60	–1.30	–0.78	–0.76	–1.05	–0.77
Myanmar	–0.99	–0.94	–1.51	–1.02	–0.62	–1.17	–0.66
Netherlands	1.63	1.52	0.86	1.84	1.76	1.75	2.03
New Zealand	1.76	1.60	1.49	1.58	1.88	1.87	2.15
Nigeria	–1.08	–0.58	–1.87	–1.12	–1.01	–0.83	–1.08
Norway	1.78	1.72	1.25	1.93	1.70	1.97	2.10
Oman	0.12	–1.14	0.43	0.14	0.46	0.62	0.23
Pakistan	–0.91	–0.88	–1.79	–0.54	–0.73	–0.69	–0.83
Papua New Guinea	–0.58	0.03	–0.70	–0.84	–0.69	–0.70	–0.58
Peru	–0.13	0.25	–0.36	–0.26	0.49	–0.38	–0.50
Philippines	–0.29	–0.10	–0.75	0.10	0.13	–0.63	–0.49
Poland	0.59	0.62	0.52	0.36	0.86	0.53	0.65
Russia	–0.67	–1.07	–0.68	–0.08	–0.47	–0.79	–0.91
Rwanda	0.00	–1.09	0.08	0.31	0.01	0.11	0.55
Saudi Arabia	–0.22	–1.61	–0.62	0.14	0.26	0.24	0.27
Slovakia	0.66	0.88	0.63	0.54	0.79	0.67	0.44
Slovenia	0.93	0.94	0.71	1.16	0.92	1.06	0.80
South Africa	0.07	0.70	–0.24	0.10	0.04	–0.18	–0.01
Spain	0.79	1.01	0.44	0.89	0.77	0.89	0.74

Country	Overall index	Voice and Account-ability	Political Stability and Absence of Violence/ Terrorism	Govern-ment Effec-tiveness	Regula-tory Quality	Rule of Law	Control of Corrup-tion
Sri Lanka	–0.12	–0.05	–0.08	–0.05	–0.21	0.01	–0.31
Sweden	1.64	1.50	1.03	1.71	1.69	1.80	2.13
Switzerland	1.71	1.54	1.19	2.01	1.59	1.82	2.08
Taiwan	1.21	1.10	0.77	1.58	1.37	1.26	1.15
Tajikistan	–1.10	–1.78	–0.51	–0.71	–1.04	–1.23	–1.33
Thailand	–0.24	–0.81	–0.58	0.23	0.08	0.12	–0.46
Turkey	–0.48	–0.86	–1.14	–0.13	–0.01	–0.41	–0.34
Ukraine	–0.53	0.09	–1.14	–0.38	–0.25	–0.69	–0.81
United Arab Emirates	0.64	–1.18	0.62	1.32	1.09	0.91	1.11
United Kingdom	1.30	1.25	0.49	1.37	1.49	1.49	1.69
USA	0.98	0.87	0.03	1.31	1.25	1.36	1.07
Uzbekistan	–0.93	–1.53	–0.43	–0.53	–0.98	–1.08	–1.05
Viet Nam	–0.33	–1.38	–0.08	0.23	–0.22	–0.16	–0.35
Zambia	–0.56	–0.43	–0.13	–0.80	–0.67	–0.63	–0.72

German Mineral Resources Agency (DERA) at the
Federal Institute for Geosciences and Natural Resources (BGR)
Wilhelmstraße 25–30
13593 Berlin
Germany

dera@bgr.de

www.deutsche-rohstoffagentur.de
www.bgr.bund.de