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Manuscript

Standardizing "green" extractivism: Chinese & Western environmental, social, and governance instruments in the critical mineral sector

Abstract

As societies attempt to transition to low-carbon energy and reduce fossil fuel dependencies, mineral extractivism is reaching new heights globally. This trend is accompanied by a surge of Environmental, Social, Governance (ESG) standards used to justify a perceived *just* transition. Through an analysis of 13 widely used international instruments and the ways mining companies adopt them, this article develops a comparative examination of Western and Chinese ESG practices, with a focus on guidelines and standards aimed at mitigating the socio-environmental impacts of extractivism. Despite conventional portrayals of Western and Chinese governance standards as disparate or in competition, we find their standards evolve in tandem and conversation in the context of the rush for critical minerals, underscoring the need to move beyond a Western-Chinese binary. This research also challenges the notion of China attempting to set global standards. Chinese companies increasingly embrace ESG principles due to reputational risks, national standardization efforts, and international partnerships. They, however, focus more on downstream stakeholders, while Western counterparts lean towards upstream considerations. Notably, guidelines are employed similarly by Western and Chinese companies, albeit influenced by geographical, material, and political considerations. We conclude with future directions for critical and social science research on climate-related extraction.

Keywords: critical minerals, ESG standards, mining firms, China, United States, Europe

I. Introduction

A 2022 *Forbes* article titled "Geopolitics is the New 'G' in ESG"[1] underscored the escalating significance of geopolitics in Environmental, Social, and Governance (ESG) considerations for global investments. This trend is exemplified across the mining sector, particularly in the increasing demand for critical minerals in support of a low-carbon energy transition that has amplified competitive dynamics across the mining and metals sector. Geopolitics that increasingly permeate mineral supply and production are extending to regulatory frameworks. Over the past decade, ESG standards for mineral sourcing and production by industry actors, non-profits, and international organizations alike have proliferated. However, these standards were largely developed under the purview of Western institutions and companies, reflecting a specific perspective on acceptable practices in mineral production and consumption networks, as American, Canadian, Australian, and European companies historically engaged in international mining endeavors. The 2022 Minerals Security Partnership (MSP), comprising Australia, Canada, Finland, France, Germany, Japan, South Korea, Sweden, the United Kingdom (UK), the United States (US), and the European Union (EU), aims to increase mineral production while emphasizing a commitment to high ESG standards. Although China is at the forefront of critical minerals production through a long history of domestic mining and has significant expansion in foreign activities, the country is not in the fold of initiatives like MSP.

As a result, Western and Chinese ESG standards are evolving in tandem in the context of the rush for critical minerals. This article develops a comparative analysis of Western and Chinese ESG practices, with a focus on mining guidelines, standards, and frameworks aimed at mitigating the socio-environmental impacts of green extractivism. While there are several aspects of the critical mineral supply chain that require ESG oversight, such as exploration, extraction, processing, transportation, refining, and manufacturing, we focus on extractive governance. We examine the similarities and differences between Chinese and Western standards and the experiences of companies in implementing such instruments and address these issues in a time of increased extractivism linked to the low-carbon transition as well as growing scrutiny and expectations from consumers, investors, and customers. Importantly, this article is a prospective exploration of these issues and introduces avenues for future research.

The response to the climate crisis is compounding the effects of extractivism on communities and ecosystems worldwide (Dunlap and Riquito, 2023; Andreucci et al., 2023). As economic blocs define critical minerals lists and other Green New Deal policies (Deberdt and Le Billon 2024), they recognize the need and increasing reliance on base minerals to electrify livelihoods. Electric vehicles (EVs), battery storage systems, solar technologies, and wind turbines require

[1] ESG is an investment philosophy and corporate standard that incorporates environmental impacts, social responsibility, and governance performance with financial performance, with the aim of fostering responsible investment.

enormous amounts of raw materials. The International Energy Agency (IEA) (2022) estimates that by 2040, 92% of lithium, 69% of cobalt, and 61% of nickel mined globally will be used by clean energy technologies under a "sustainable development" scenario. These numbers would entail an increase in production of 42, 21, and 19 times, respectively.

China largely dominates the extraction and production of critical green minerals—those minerals essential for current and future low-carbon technologies, which are difficult to substitute and vulnerable to supply chain disruptions (Castillo and Purdy, 2022). In the past two decades, the country has made investments in foreign jurisdictions (primarily in the Global South) to acquire strategic deposits, all the while establishing immense processing capacities within its borders. However, as Deberdt and DiCarlo (2024) suggest, these investments are also highly dependent on complex local, provincial, and national systems in the extractive jurisdictions. In parallel, domestic supplies of REEs and copper have significantly increased. China now produces 63% of the world's supply of rare earth elements (Seligman, 2022). At this intersection between green extractivism, critical minerals, and the scale of China's extractive sector, Western countries have hastened efforts to secure foreign resources and boost domestic production.

Mining, for a green transition or otherwise, continues to be marked by exploitative and harmful practices. Despite a narrative of just transition (or transition for all) that links climate, environmental, and social equity within a single framework (Bruna, 2022), the green transition is under scrutiny for its practices. Child labor in Congolese artisanal cobalt mines (Batano, Doevenspeck, Biningo, 2023), water attrition in Argentinian lithium operations (Ciftci and Lemaire, 2023), and environmental pollution from rare earths mines in China have made headlines and attracted significant unwanted attention. Similarly, the nimbyism of Western communities visibilizes green extractive projects within the US, Canada, and Europe, including their potential negative impacts. Thus, the development of technocratic instruments such as guidelines, standards, and frameworks responds in part to this increasing pressure to produce responsibly.

Chinese firms and organizations have increasingly prioritized ESG and socio-environmental standards across various sectors, prompting debates on whether China will emerge as a global standard-setter. The process of integrating Western-led instruments within the governance structures of such economic actors pushed the country to develop a domestic response. As a result, China's norm-making in global extractive governance is, in part, a strategic choice that allows the state to cope with China's internal and external legitimacy crises, and to solidify its emerging identity as a responsible great power (Park, 2023a). Others highlight the "proactive" engagement on labor rights of Chinese companies with other actors in their supply chains with processes of normative settling and behavioral changes being spurred by scrutiny from Western-based organizations (Chen, 2021). In either view, by virtue of its increasing transparency and ESG and its status as a green manufacturing powerhouse, China has embraced the development of standards to increasingly satisfy Chinese and Western customers and clients.

II. Methodology

This article is based on analysis of a set of guidelines, standards, and/or frameworks and their application by a selected group of Western and Chinese companies. Considering the vast array of both instruments and implementers, we conducted a strict selection.

2.1. Selection of instruments

This article is based on the analysis of 13 ESG guidelines, standards, and/or frameworks related to mineral extraction (Table 1). These minerals are used in the manufacturing of products deemed green within the low-carbon transition, including critical minerals as defined by the US, EU, and China, and extending beyond these lists. EVs, solar panels, battery storage systems, and wind turbines are just some of the products that ensure the electrification of carbon-based livelihoods. The guidelines we selected address the sustainability and responsible production and trade of mineral-related operations, including extractive sites, processing facilities, and other supply chain actors. They are used by companies worldwide to address responsible sourcing risks and practices and cover mineral agnostic instruments applicable to any mineral resources, as well as more specialized tools addressing risks in specific commodities. These tools include ESG indicators but vary in level of detail for each category. Although guidelines provide umbrella mechanisms for each category, including the structure for implementation of responsible production, standards center on-the-ground implementation at company or site levels. We selected standards that applied at site- and company-levels, thus excluding those exclusively focused on supply chain due diligence. Site-level standards are those applicable at each extractive operation of a company, thus leading to multiple verification per selected companies. Company-level standards encompass those implemented at the corporate level, meaning a single verification for the whole company and the entirety of its operations.

Table 1 - Guidelines, standards, and framework selected for this research

Category	**Instrument**	**Organization**	**Type of organization (country of registration)**
Overall guidelines	Chinese Due Diligence Guidelines for Responsible Mineral Supply Chains (RMSC)	China Chamber of Commerce of Metals, Minerals and Chemical (CCCMC)	Industrial non-profit social organization (CN); a *Shanghui* or Chamber, which is an industry membership organization
	Due Diligence Guidance for Responsible Supply Chains of Minerals from Conflict-Affected and High-Risk Areas	Organization for Economic Co-operation and Development (OECD)	International organization (FR)
Market requirements	Responsible Sourcing Requirements	London Metal Exchange (LME)	Private unlimited company (UK)

Mineral agnostic standards	Chinese Guidelines for Social Responsibility in Outbound Mining Investments (SROMI)	China Chamber of Commerce of Metals, Minerals and Chemical (CCCMC)	Industrial non-profit social organization (CN)
	10 Principles	International Council on Mining and Metals (ICMM)	Private company limited (UK)
	Standard for Responsible Mining	Initiative for Responsible Mining Assurance (IRMA)	Nonprofit (US)
	Toward Sustainability in Mining	Mining Association of Canada (MAC)	Nonprofit (CA)
	Environmental, Social & Governance (ESG) Standard for Mineral Supply Chains	Responsible Minerals Initiative (RMI)	Project of a nonprofit (US)
	Global Responsible Sourcing Due Diligence Standard for Mineral Supply Chains All Minerals	Responsible Minerals Initiative (RMI)	Project of a nonprofit (US)
Mineral-specific standards and frameworks	Cobalt Industry Responsible Assessment Framework	Cobalt Institute	Private company limited (UK)
	Copper Mark Criteria for Responsible Production	The Copper Mark (originally, the International Copper Association, ICA)	Private company limited (UK)
	Responsible Gold Guidance	London Bullion Market Association (LBMA)	Private company limited (UK)
	Code of Practice	Responsible Jewellery Council (RJC)	Private company limited (UK)

2.2. Selection of mining companies

We identified major mining companies that implement one or more of the above guidelines. We selected five China-headquartered mining companies and five Western-headquartered companies (Table 2). We chose to limit this analysis to these 10 companies for several reasons. First, the identified instruments are generally implemented by large companies of a certain size. Small to medium size companies are limited in their participation because they may not have the financial ability to go through audits and tend to lack a dedicated ESG team. Our focus on multinational companies favored the selection of a small set of very large companies. Finally, we elected to focus on companies extracting critical minerals. We recognize the limitations of such an analysis, bounded by a highly visible set of corporate actors. Thus, we do not suggest that the findings of this article apply to all companies, of all sizes, and all origins.

We identified companies using the Mining.com (2023) ranking of the fifty largest mining companies worldwide, based on market capitalization. However, for Chinese operators, and accounting for the importance of state-owned, non-traded companies, we also integrated firms based on perceived reach and scale of business. We prioritized diversified companies, meaning

enterprises extracting more than one mineral, before selecting mineral-specific companies. This is largely the result of specialization in the Chinese mining sector, with most companies focusing on the extraction of a single commodity. Finally, we excluded companies with exclusive fossil fuel (oil, gas, and coal) operations as well as exclusive precious metals (gold, silver, PGM, diamonds, gemstones) as these do not supply critical minerals used for the manufacturing of green products.

We conducted a document analysis of company-produced reports as well as a scraping of publicly available information related to ESG implementation. For the former, we used company sustainability reports to assess their use of guidelines and standards. We selected the most recent accessible report for each company. For both Western and Chinese companies, we focused on those published in 2023 and 2022. We acknowledge that company sustainability reports offer a limited view of how effectively guidelines are implemented and might contain self-reporting bias, limited scope, and potential greenwashing. However, they provide valuable insights into how companies perceive and communicate their sustainability efforts, offering a starting point for understanding their priorities and areas of focus. By analyzing what information is included and what is omitted, we are able to identify potential gaps in strategies and reporting. This exploratory paper, although based on a small sample size, aims to uncover key themes and trends in mining ESG practices. Our findings may not be generalizable to all Western and Chinese companies due to the limited sample size. However, this study serves as a foundation for expanding future research in this area.

Table 2 - Companies selected for this research

Categories	**Companies**	**Market capitalizations***	**Country of headquarters**	**Country/ies of operation****
Western companies	BHP Group	156.034B	Australia	Australia, Brazil, Canada, Chile, Peru, US
	Rio Tinto	113.171B	Australia/United Kingdom	Australia, Canada, Iceland, Madagascar, Mongolia, New Zealand, South Africa, US
	Glencore	64.298B	Switzerland	Canada, Chile, DRC, Kazakhstan, Peru, South Africa, US
	Freeport-McMoRan	56.671B	US	Chile, Indonesia, Peru, US
	Anglo American	24.414B	United Kingdom	Australia, Botswana, Brazil, Canada, Chile, Namibia, Peru, South Africa,
Chinese companies	Zijin Mining	42.477B	China	Australia, China, Colombia, DRC, Serbia, Suriname, Tajikistan
	CMOC Group	15.588B	China	China, DRC, Brazil
	Ganfeng Lithium	10.645B	China	Argentina, Australia, China, Ireland, Mali, Mexico

	Jiangxi Copper	7.9B	China	Afghanistan, China, Peru
	China Nonferrous Metal Mining Group	N/A	China	DRC, Zambia

* Market capitalization as of January 25, 2024 provided by Yahoo Finance.
** Only countries with effective operations are listed, not countries with projects in development. These are only mining operations and do not account for refining-only sites.

III. A recent history of ESG development and mining guidelines

The term "Environmental, Social, and Governance" gained prominence following the influential study "Who Cares Wins," a joint initiative of financial institutions through the United Nations. The study and subsequent conference played a pivotal role in elevating recognition and adoption of ESG considerations in asset management and financial analysis. ESG is often viewed as a subset of corporate social responsibility (CSR) encompassing the near to medium-term efforts of economic entities in terms of environmental stewardship, social responsibility, and ethical business practices. The evolution of ESG frameworks and reporting standards, however, can be traced to events, such as the 1992 inaugural Earth Summit, the 2006 establishment of the Principles for Responsible Investment (PRI), and the 2011 creation of the Sustainability Accounting Standards Board (SASB). Initially tailored toward investors, ESG faced criticism for primarily offering insights into "the potential impact of the world on the company and its shareholders" while not "measur[ing] a company's impact on the Earth and society" (Simpson, Rathi and Kishan, 2021). Despite this profit maximization perspective, the rise of ESG considerations has played a crucial role in mitigating the socio-economic impacts of corporate investments on a global scale. In mineral-related sectors, ongoing efforts by international organizations, enterprises, and non-profit organizations to establish guidelines for production, processing, and trade underscore the importance of proactive planning, governance practices, and monitoring of social and environmental impacts throughout the supply chain.

The extractive sector's production and sourcing standards were influenced by CSR concerns regarding Western companies' roles in sustaining regimes with poor human rights records. Notably, backlash against Shell and others operating in Apartheid South Africa led to disinvestments, contributing to economic pressures that triggered the regime's downfall under Frederik de Klerk. The pressure on Shell was one of the first instances in which the role of companies' sourcing and business practices in supporting socio-political causes was clearly articulated (Minefee and Bucheli, 2021). Subsequently, the blood diamond campaigns of the late-1990s echoed these concerns while directly linking a specific commodity to both human rights abuses and wealthy (Western) companies and customers (Le Billon, 2008). The campaigns exposed injustices within the diamond trade from Angola, Sierra Leone, and Liberia, leading to the 2003 establishment of the Kimberley Process Certification Scheme (Haufler, 2010) which opened a new wave of responsible sourcing practices that have since imbued other raw

commodities standards. Building on the international certification system for rough diamonds, a new campaign was spurred by the continuous conflicts affecting the (DRC) and targeted so-called *conflict minerals*. In response to pressure from US lawmakers and Western civil society groups, the OECD devised guidelines for due diligence (see Section IV), which was later adopted by Washington and Brussels. Concurrently, standards were developed to operationalize the OECD Guidance and meet legal requirements. In 2016, the cobalt industry, under scrutiny after the publication of a damning report by Amnesty International and AFREWATCH (2016), quickly acted to avoid the imposition of mandatory due diligence and developed a flurry of voluntary standards. These new instruments aim to insulate the reputation of corporate actors from the complex realities of mining and are aligned with an ESG approach to financial investment protection.

Public attention to mining industry abuses has followed two parallel strategies—one focused on artisanal and small-scale mining (ASM) and the other on large-scale mining (LSM) operations. The former, associated first with the blood diamond and conflict minerals campaigns, and later in the cobalt sector, directly linked the sourcing practices of downstream, customer-facing companies to abuses. Funding warlords and child labor were mobilized as a shaming strategy to force companies to act on the impacts of their mineral needs. The latter was largely driven by industrial mining companies first to secure governmental permits and licenses to operate and then to provide downstream clients with the assurance required by their investors and individual customers.

Western LSM relies largely on processes of internal assessment, meaning that standards have been developed by the mining companies themselves.[2] While historical standards-setting organizations of LSM set the bar for future responsible production and sourcing frameworks,[3] the Western mining sector seems to have embraced a supply chain approach only recently. In ASM, due to the absence of artisanal operations in Western contexts, externally imposed standards focus on supply chain linkages, promoting mapping, and then engagement with the extractive sites.

The origins of China's mining guidelines are also related to conflict minerals but are now deeply entangled with the rush to secure mineral supplies for the low-carbon transition. In response to the DRC's 2012 law requiring supply chain due diligence, two Chinese companies, TTT Mining (CMM) and Huaying, were suspended for legal noncompliance and potentially sourcing from conflict areas. Despite an investigation, their suspension was lifted in March 2013, and the companies resumed exporting minerals and expanded DRC operations. In October 2013, the DRC Minister of Mines reminded the industry of due diligence obligations. Global Witness's (2014) review of CMM's and Huaying's due diligence reports revealed inadequacies in meeting

[2] IRMA is the only LSM focused standard that has been developed with significant stakeholder inputs and which retains a multi-stakeholder nature. Nevertheless, the standard was also the result of the input of mining companies.
[3] For example, the Mining Association of Canada's Toward Sustainability in Mining was introduced in 2004.

Congolese law, particularly in risk assessment and management. Both companies acknowledged the need for improvement in their 2014 reports.

Following these pivotal events, CCCMC[4] embarked on a standard development process to support responsible investments and mineral production by Chinese companies, domestically and abroad. With support from the German development agency GIZ (Global Witness, 2014), they introduced the 2014 Guidelines for Guidelines for Social Responsibility in Outbound Mining Investments (SROMI; 中国矿业投资社会责任指引). Aligned with the "going out" strategy, the guidelines were operationalized through the Chinese Due Diligence Guidelines for Responsible Mineral Supply Chain Management (RMSC; 中国矿产供应链尽责管理指南), developed in partnership with the OECD during a workshop held in Beijing. Drawing from OECD expertise and tailored to Chinese companies engaged in mineral supply chains, RMSC were designed to prevent and address risks related to conflicts, human rights violations, and unethical practices. They provide guidance for companies to categorize risks, establish risk management systems, carry out third-party audits, and report on due diligence policies and practices. Both Guidelines were furthered by the 2016 Sustainable Mining Action Plan (可持续矿业行动计划) in partnership with the British Department for International Development that introduced a 3-year implementation plan (EMS, 2016; UNDP, 2018). Furthermore, they were updated to new editions in 2017 and 2022 respectively to reflect the new development of international standards and industry practice.

Beyond mineral-agnostic, global instruments, CCCMC has been instrumental in spearheading more targeted tools, materially and topically. In 2016, amidst heightened scrutiny of cobalt operations in DRC, CCCMC collaborated with the Responsible Minerals Initiative (RMI) to launch the Responsible Cobalt Initiative and develop Cobalt Refiner Supply Chain Due Diligence (钴冶炼厂供应链尽责管理标准) to enhance transparency and accountability within cobalt supply chain. Furthermore, in 2023, CCCMC introduced the Mediation and Consultation Mechanism for the Mining Industry and Mineral Value Chain (采矿业和矿产价值链调解磋商机制: 程序文件) with the objective of facilitating communication and consultation among diverse stakeholders. Finally, in the same year, CCCMC initiated a pilot consultation mechanism to standardize mining ESG practices in response to increasing critical minerals demand and related risks.

Chinese companies and institutions recognize the importance of ESG principles and socio-environmental standards across industries, for reasons of reputational risks, increased country-level standardization, and because they often form joint enterprises with non-Chinese companies. The China Enterprise Reform and Development Society (CERDS), under the State-owned Assets Supervision & Administration Commission (SASAC), introduced voluntary disclosure through

[4] Founded in 1988, CCCMC is an industrial non-profit organization that represents the metals, minerals, and chemicals import and export industry in China. Its members are large-scale and small and medium-sized enterprises in the industry.

the Guidance for Enterprise ESG Disclosure (企业 ESG 披露指南). In practice, however, the current state of company ESG is one of experimentation.

Chinese companies are actively exploring, experimenting, and improving their ESG practices, with a focus on aligning with CCCMC and international standards while also addressing unique institutional and regulatory characteristics. As of 2020, approximately 208 Chinese companies had joined 24 transnational extractive governance initiatives and adopted their standards (out of 48), which shows Chinese companies' active engagement with the existing ESG standard structure (Park, 2023b). Yet, China's extractive governance is often characterized as fragmented due to voluntary implementation and minimal monitoring and oversight. An often-cited complaint from Western actors is that Chinese companies are not held to the same stringent ESG requirements. However, Chinese officials are working to standardize ESG practices, reporting, and guidelines. Indeed, ESG has become a defining feature of China's corporate governance and of Chinese leadership as they forward green transformations across the economy, while also aiming to attract investment within China and compete with companies internationally. This research is also more broadly inscribed in the behavior of Chinese companies in conducting investments abroad. As Camba (2022a) describes, Chinese firms tend to favor investments in countries with leaderships perceived as strong from subjective and relational factors. While this approach can be considered more stable from an investor view, it can also necessitate and justify the use of standards and framework that mitigate some of the socio-economic and environmental abuses of such strong regimes. As is the case in the Philippines under President Duterte, Chinese companies, however, also mobilize less stringent standards as a strategy to secure contracts which would be delayed by competitors more careful socio-economic and environmental safeguards (Camba 2022b). In a comparison between domestic and foreign investments, Gallagher and Qi (2021) also point to the weaker environmental policies governing overseas investments of Chinese companies, based on mostly voluntary approaches.

Ongoing debates about whether China would comply with or challenge global standards hint at the increasing pressure on Chinese firms to swiftly adopt and improve standards, driven in part by heightened global competition in critical minerals. Looking across mineral guidelines development, it is clear that the resource, scale of mining operation, and type of impact have shaped Western and Chinese standards development in parallel. Interestingly, Western guidelines began as larger overarching frameworks, particularly due to ASM and conflict minerals. They, however, have moved toward a more supply chain focus. The opposite can be said for Chinese ESG development, which began with supply chain standards and more mineral-specific approaches and is now experimenting with broader mining sector guidelines. Finally, as the preceding summary supports, although we categorize standards as "Western" and "Chinese," this false binary is oversimplified and does not capture the full complexity of the differences and similarities, a point we return to later in this article. In this vein, the debate on whether "China"

will be a global norm setter, breaker, or challenger overshadows the importance of Chinese companies' agency in the context of ESG experimentation.

IV. Mining standard comparison

In the last decade, the escalating demand for responsible sourcing and production practices has catalyzed a proliferation of standards within the mining industry. These guidelines, market requirements, standards, and frameworks aim to instill confidence in consumers increasingly conscious of sourcing impacts and the investing community's emphasis on ESG principles. They outline applicable standards and offer guidance on conducting internationally-accepted verifications. Market requirements encompass the verifications that operations and companies must meet to be accepted within global markets like the London Metal Exchange (LME).

Standards are actionable documents comprising indicators used by third parties to assess the performance of a site or company. Frameworks are typically based on existing standards and do not require a third-party verification. In this paper, we identify thirteen widely-used instruments for reporting on mining operations, covering diverse topics such as climate change, worker rights, water consumption, governance, and child labor, among others. In what follows, we describe each standard, its reach, and its applicability. We address the structure of the standard-setting organizations, their governance structure, and material, geographical, and corporate scope based on the information in Table 3.

Table 3 - Overview of selected guidelines, standards, and frameworks

	Overall Guidances		Market requirements	Mineral Agnostic						Mineral Specific			
	Chinese Guidelines for RMSC*	**OECD DDG**	**LME RSR**	**Chinese Guidelines for SROMI****	**ICMM 10 Principles**	**IRMA**	**MAC TSM**	**RMI Global Standard**	**RMI RMAP ESG**	**CIRAF**	**CopperMark**	**LBMA RGG**	**RJC CoP**
Intended Audience ***	Any Chinese company	Any company	LME-listed companies (LME Brands)	Mineral exploration, extraction, processing and investment cooperation projects in which Chinese companies have invested inside and outside China	ICMM members	All mining companies	All MAC members	All processors	All processors	Mining companies	Mining companies	All refiners producing LBMA Good Delivery gold bars	RJC member companies (from extraction to commercial sales)
Commodities covered	All minerals	All minerals	Aluminum, aluminum alloy, cobalt, copper, lead, nickel, tin and zinc	All minerals	All minerals	All minerals	All minerals	All minerals	All minerals	Cobalt	Copper, molybdenum, nickel, zinc	Gold	Gold, silver, platinum, diamond, and colored gemstones
Applicability (corporate or facility level)	Corporate level	Corporate level	Corporate level	Corporate level	Corporate level	Site level	Site level	Site level	Site level	Site level	Site level	Corporate level	Corporate level
Assessment and enforcement	N/A	N/A	Track A - assessed against LME-approved standard by LME-approved assessment company Track B - audited against LME-approved standard by approved	N/A	Third-party audit company or individual auditor approved by ICMM and follows ISAE 3000	SCS Global Services and ERM Certification and Verification Services	Third-party audit company approved by MAC	Third-party audit company approved by RMI and follows the ISO 19011	Third-party audit company approved by RMI and follows the ISO 19011	N/A; self-assessed	Third-party audit company or individual auditor approved by CopperMark and follows ISO 19011 and ISAE 3000	Third-party audit company approved by LBMA and follows ISAE 3000	Third-party audit company approved by RJC and follows ISO 19011

			audit company Track C - LME assessed										
Cross recognition****	No official recognition but supported by OECD	No official recognition but OECD supported the Chinese Guidelines for RMSC	List of LME approved standards: ASI, CCCMC, RMAP ITA-RMI, ITA-RMI, CopperMark, Joint RMAP, LBMA RGG, RMI RMAP Cobalt, RMI Global Standard, RMI RMAP Tin Tungsten	N/A	Partial equivalency of RMI RRA, CopperMark, RJC CoP, MAC TSM	N/A	N/A	Top-off audit for RJC and LBMA audited companies. Upstream mechanisms Recognition: RCS Global - Better Mining ITSCI (waiting confirmation)	Top-off audit for RJC and LBMA audited companies.	N/A	CopperMark recognizes RMI's Risk Readiness Assessment (RRA) and Ecovadis (for self-assessment only).	Top-off audit for RMI and LBMA audited companies.	Full third party audit for RMI and LBMA audited companies.

* Responsible Minerals Supply Chains

** Socially Responsible Outbound Mining Investments

*** All companies in scope are involved in the extraction, transformation, and trade of minerals or the use of minerals in their products.

**** Cross-recognition also addresses simultaneous and joint audits

Ongoing mining standards creation is largely driven by a private sector push to establish voluntary, often self-regulatory systems (Franken, Turley, and Kickler, 2020; Sarfaty and Deberdt, 2023). The growing concern surrounding CSR practices since the 1980s has pushed companies to develop guidelines for engagement with all stakeholders as well as to measure their performance.[5] The notion of due diligence across complex and often unstable minerals chains was officially conceptualized by OECD Guidance (Liberti, 2012). The OECD embraced a public-private collaboration in the development of this document that is now accepted as the international norm for standard-setting organizations and the structure of their measuring instruments. First developed as a response to the conflict minerals challenge, with tin, tungsten, tantalum, and gold sourcing from Eastern Congo described as fuelling conflicts (Deberdt and Le Billon, 2021; Radley and Vogel, 2015), the OECD Guidance has since then been used in virtually all mineral commodities. Legal texts, including the Dodd-Frank Act Section 1502 (on conflict minerals see Sarfaty, 2015), the EU Regulation 2017/821 (on conflict minerals, see Voland and Daly, 2018), and the EU Regulation 2023/1542 (on batteries, see Sten, 2023) recognize the guidance as the

[5] For a history of corporate social responsibility, see Agudelo, Jóhannsdóttir and Davídsdóttir (2019)

basis of their due diligence requirements. Similarly, recent market requirements introduced by the LME, the largest base metal market globally, assess compliance standards with regard to their alignment with the OECD Guidance (Bernards, 2021).

Nevertheless, OECD Guidance remains a Western-driven initiative that, while recognized as the gold standard of due diligence system implementation, remains poorly applied in other regions of the world. To address this gap, CCCMC engaged the OECD to develop their due diligence guidelines (Buhmann, 2017). The Chinese Guidelines for RMSC provide a framework to operationalize the Guidelines for SROMI (OECD n.d.). In parallel, they help Chinese companies align with international due diligence practices, thus responding to downstream concerns of companies, individual consumers, and investors. Research shows that Chinese operators are increasingly aware of and performing due diligence (Saegert and Grossman 2018). However, gaps remain, and only 34% of the country's listed mining companies publish a CSR report (Peng et al., 2020). Additionally, the voluntary nature of the Chinese guidelines risks creating what Gessler (2017: 2) describes as 'paper tigers' that "give the impression that Chinese regulators are 'getting tough', at least rhetorically, on wayward companies operating in developing countries."

These guidelines respond to the imperative to harmonize the multitude of standards being developed by various stakeholders in the mining sector, including industry players, non-profit organizations, and international bodies. Table 3 illustrates the divergences and intersections between both mineral-agnostic and mineral-specific standards. With the exception of MAC TSM, all standards and frameworks use OECD Guidance as their basis, while the Chinese Guidelines are only recognized by its equivalent standard, the Guidelines for SROMI. This situation can be read in two directions. First, the Chinese approach offers a singular standard for all mining enterprises, thereby averting the proliferation of disparate instruments with varying levels of accountability. Second, the absence of standards tailored to specific minerals, sites, and/or scope could be perceived as limiting, potentially overlooking the complexities of each mineral and production network.

The Guidelines for SROMI, framed by international best practices, including the ISO 26000 Guidance, recognize the Ten Principles of the UN Global Compact and align with Beijing's Guiding Opinions on Performance of Social Responsibilities by State-owned Enterprises (SASAC, 2011). Beyond these tools, the guidelines explicitly note the importance of Western-based mining standards in orienting the development of Chinese tools. For example, Annex I of the Guidelines for SROMI lists the ICMM and RJC as the main standards considered during the process (CCCMC, 2014).

The Western environment for mining and mineral-related standards is marked by a proliferation of industry-developed instruments. MAC TSM and, subsequently ICMM's Principles constitute historical examples of mining industry efforts to self-regulate to secure governmental permits and socio-economic licenses to operate. While MAC TSM is geographically oriented around Canadian mining operations, ICMM has a broader reach but remains interested in the extractive site without supply chain considerations. More recent standards such IRMA's or the CopperMark also include a mining focus, while other instruments introduced supply chain considerations (RMI, LBMA, RJC), which are then used to respond to government legislation

and market requirements (LME) as they are officially and unofficially untrusted with (almost) legal obligations (Sarfaty and Deberdt, 2023).

The material scope of many standards and frameworks also differs. While some are applicable to all minerals, others focus on the specificities of one or a few commodities. These differences often result from the organization entrusted with standards creation and appear to lead to few material-specific requirements. For example, CIRAF uses a set of accepted standards, including the ICMM or IRMA, both mineral agnostic. Nevertheless, developed by the Cobalt Institute and its corporate members, the tool is marketed as a cobalt-specific instrument without much mineral specificity. In other cases, for example LBMA or RJC, commodity-specific connections are made clearer by their attention to different processing stages. For example, while gold mining is similar to other forms of metallic metals mining, it entails specific processing and material challenges.[6] In light of our comparative analysis, we acknowledge the many acute differences between standards, their enforcement, and material extraction and processing. It is often extractive companies themselves that are charged with the development of standards and frameworks (e.g., ICMM, CIRAF, CopperMark) under the umbrella of multistakeholder-developed instruments. In the following section, we analyze standards through their applications by major mining Western and Chinese companies.

V. Company ESG practices: between implementation and discourse

Despite strengthening safeguards, a recent study by GlobalData found that of the top ESG performers in the mining sector, none are Chinese companies, despite their scale of investment worldwide (Mining Technology 2022). In this section, we examine how companies have adopted and implemented standards for particular projects, and examine discourses embedded in ESG standards, frameworks, and company language related to their implementation. We consider adoption of the instruments as their implementation and/or involvement in their development, and not only their mention in the sustainability reports.

[6] For example, gold smuggling is rendered easy by the very low quantity needed for significant financial gains. This is different for more industrial minerals such as cobalt or copper.

5.1.Major Western Mining Companies

This section centers on information disclosed by Western mining companies through their sustainability reports and dedicated online sustainability pages. Importantly, this research is not intended to be an assessment of on-the-ground practices, nor does it build on ethnographic inquiries at the different extractive sites these companies developed worldwide. Each company offers a sustainability report, except for Rio Tinto, which has not released such a document since 2019. Nevertheless, Rio Tinto provides comparable information through its annual factbook, albeit in a less user-friendly format.

Table 4 - Western mining companies and adopted standards

Western Mining Company*	**ESG Standards Applied****
BHP Group (2023)	OECD, LME, ICMM, TSM, CopperMark,
Rio Tinto (2022)	OECD, ICMM, TSM, CopperMark, LBMA, RJC
Glencore (2022)	OECD, LME, ICMM, TSM, CIRAF, CopperMark, LBMA, RMI RMAP,
Freeport-McMoRan (2022)	OECD, LME, ICMM, CopperMark
Anglo American (2022)	ICMM, TSM, CopperMark, IRMA, RJC

* In parenthesis is the year of publication of the sustainability reports analyzed for this study.
** From the 13 previously selected..

OECD Guidance is regularly cited in reports of BHP Group, Glencore, and Freeport-McMoRan as the backbone of their responsible production and sustainability systems. Rio Tinto, the only company under the scope of the conflict minerals rule (Section 1502, Dodd Frank Act), and Anglo American do not address the Guidance. Similarly, LME requirements are mobilized by companies to justify the use of the production standards explored below. Glencore raises the market-based, LME requirements, at a level comparable to state regulations. Freeport-McMoRan links three instruments directly together, highlighting the overlaps of such responsible sourcing tools. The company is certified against the CopperMark, which is aligned with the OECD Guidance to respond to LME requirements.

Of the five companies selected, all recognize the ICMM 10 Principles as a core sustainability tool at their disposal. This is largely because ICMM is the oldest and largest industry organization with a specific focus on mining sector challenges. Interestingly, of the members, only one company is China-based, MMG. ICMM and its guidance is widely used as the benchmark on social and environmental topics. BHP Group, for example, regularly reaffirms that

the findings align with ICMM requirements, especially on water-related topics. Other companies, such as Glencore, use the framework in a more systematic way, providing compounded results at the corporate level on the alignment of assets with the requirements set forth by ICMM. The difference is visible, with Glencore mentioning ICMM 114 times through its report while BHP Group raising it only 27 times. Anglo American mobilizes both mineral-agnostic and mineral-specific standards to respond to ICMM subject matter. Thus, standards are used to align with other industry standards in a pyramidal approach of specificity.

Four of the five companies include operations within Canada and thus use MAC TSM protocols. Similar to the ICMM, the TSM framework is mobilized unequally by Western–headquartered companies. Generally, TSM is mentioned in passing in the reports, with Anglo American and Glencore mentioning it twice and BHP Group once. Rio Tinto expands briefly on its use in an online page dedicated to standards. The framework is a requirement for membership in the Mining Association of Canada. However, this is conducted largely by the Canadian entities of each mining company (e.g. Rio Tinto Canada, Glencore Canada) and seems to be partly ignored in sustainability reporting by the global headquarters. We suggest two possible and related explanations for this discrepancy. First, a localization of sustainability information provision. Second, a hesitation to provide detailed information on corporate practices for companies with different sustainability practices globally. This pattern is echoed by the track record of incidents and lawsuits that trail companies such as Glencore and the significant gap between its Canadian operations' sustainability practices and the recurring accusations of corruption, environmental pollution, or human rights issues in the DRC for example.

CopperMark is an example of rapid and wide adoption of a mineral-specific instrument as all companies use it. The unequal implementation of the framework is even more visible in the case of CopperMark. While Freeport-McMoRan mentions it 37 times in its sustainability report and includes a full section on a description of current and targeted achievements, Glencore and Anglo American both only address it once. The latter mobilizes the framework in a particularly interesting way, as a temporary fix before receiving validation against the stringent IRMA standard. The company asserts that "Los Bronces and El Soldado sites have adopted Coppermark certification while they wait to be assured against IRMA" (Anglo American, 2023: 87). Finally, the implementation of the CopperMark is geographically circumscribed with South American and Australian operations, while mines in more risk-prone locations do not engage with the framework.

Finally, Glencore constitutes an interesting case study in the cobalt sector for its implementation of instruments linked to both operations and supply chains. The company does not publicize its use of RMI's RMAP standard as well as the CIRAF framework in its sustainability report but provide site-specific individual reports for its two main cobalt operations in the DRC. The reports stating alignment with RMAP largely equate to a presentation of sustainability strategy loosely aligned with the OECD Guidance 5-Step framework, while highlighting a few engagements with outside stakeholders. The CIRAF report has only been published in 2020,

despite the Cobalt Institute requirement for annual reporting. Interestingly, at the time of writing of the CIRAF report, the Mutanda site, the largest cobalt operation worldwide, which also gathers most of the criticisms about Glencore's human rights and environmental record, was under care and maintenance. The site was consequently excluded from the report.

The adoption of guidelines, standards, and frameworks by Western mining companies to meet customer demands, market expectations, and legal mandates manifests in diverse approaches. The uneven utilization of standards reinforces the fragmentation of responsible practices, fostering "pick-and-choose" approach of selective adherence that prioritizes corporate interests based on operational locations or economic considerations. There are instances where discrepancies exist within companies, particularly those with operations in multiple jurisdictions, influencing the application and execution of standards. Overall, the proliferation of instruments obscures transparency by complicating compliance requirements. Amidst this complexity, the Global Reporting Initiative (GRI) emerges with consistency in corporate reporting, as it emphasizes reporting methodologies rather than the substance of the disclosed information. The forthcoming section offers a comparison alongside the Chinese context, raising important findings about how standards are developed, implemented, and understood.

5.2. Major Chinese Mining Companies

We analyze five Chinese mining company's ESG reports as primary data and cross-check it with other website-based data. The companies began publishing annual ESG and sustainability reports in the past five years with a majority of them making their 2022 ESG reports available in English and Chinese on their websites, with the exception of China Nonferrous Metal Mining Group (CNG), a central state-owned entity, whose latest report is currently inaccessible. Notably, all five companies emphasize that their ESG reports adhere to the GRI reporting standards, indicating a collective move towards standardizing reporting practices within the Chinese mining industry, and with Western actors as we discussed above.

The companies actively promote a sustainability vision that aligns with their strategic positioning in the global market, emphasizing green growth and renewable energy transition. Interestingly, most companies maintain dedicated "sustainability" sections on their websites in both English and Mandarin. Through these platforms, they publish ESG reports, supplier codes of conduct, and elaborate on their sustainability objectives. Such information-sharing can be interpreted as a management strategy targeting "international audiences" due to increasing pressure from the public and foreign stakeholders on companies operating in multiple countries. In this context, it is noteworthy that all five companies adopted and applied one or more identified ESG standards.

Table 5: List of Chinese companies and the ESG standards they employ or mention.

Companies*	**ESG Standards Applied***

Zijin Mining (2023, 2022)	CCCMC, OECD, LME, LBMA
CMOC Group (2023, 2022)	CCCMC, OECD, ICMM, RMI RMAP, CIRAF, CopperMark
Ganfeng Lithium (2022)	CCCMC, OECD
Jiangxi Copper (2022)	LME, LBMA
China Nonferrous Metal Mining Group (2023, 2022)	LME

* In parenthesis is the year of publication of the sustainability reports analyzed for this study.
** From the 13 previously selected

Chinese companies frequently reference the OECD Guidance and CCCMC Guidelines in their reports. Notably, these two frameworks are often presented in tandem as a comprehensive approach to conducting due diligence for sustainable supply chains. CCCMC Guidelines can be viewed as a version of internationally-recognized ESG, tailored for Chinese companies by combining global standards and Chinese companies' needs based on local context, reflecting a process of norm-localization (Park, 2023a). In other words, they are a product of China's internalizing global standards, such as the ICMM 10 Principles, which were recognized by each Western company in our analysis. The Chinese company cases point to a trend of upholding Chinese-specific standards over existing international frameworks. For instance, Ganfeng Lithium updated and enhanced due diligence management procedures of supply chains in 2021, "to secure lithium supply chains," using the OECD Guidance and the two CCCMC Guidelines, showcasing Chinese mining companies' proactive engagement with global ESG through experimentation and implementation.

Three out of five companies (Zijin Mining, Jiangxi Copper, CNG) adopt LME requirements and two companies (Zijin Mining and Jiangxi Copper) apply LBMA. These global frameworks are consistently highlighted by Chinese mining companies following the OECD Guidance and CCCMC Guidelines, although they are not always prominently featured in sustainability statements. Chinese companies began engaging with the LME as early as the 1990s (Jiangxi Copper Company 2022), recognizing these standards as essential for market access and directly linked to their product's brand value (including product grade, such as CNG's "Grade A Copper" in the LME). Consequently, companies align sustainability strategies to meet market demands. For example, in its 2022 ESG report Jiangxi Copper details its efforts to update due diligence protocols in response to LBMA requirements (which align with the OECD Guidance). The strategic adoption of ESG standards underscores companies' response and maneuver in relation to market-driven imperatives for their business interests (Park, 2023b).

As for other adopted standards, ICMM, RMI RMAP, CopperMark, and CIRAF are mentioned but only by CMOC Group which became a joint-stock private company after its ownership reforms in 2004 and 2014.[7] CMOC underscores its motivation to adopt standards by emphasizing the globality of the company that "recognizes international and Chinese stakeholders' expectations of sustainability-related issues…and strict regulatory requirements"[8] and applies sustainability policies "in line with international good practices" (CMOC, 2022: 46). Among Chinese companies, CMOC is particularly active in the ESG space. Of note, CMOC is the Vice President of CCCMC and a member of the Cobalt Institute, which launched CIRAF in the cobalt sector (CMOC, 2022: 7). The company details its sustainability risks management related to DRC cobalt mining in the 2022 sustainability report. This includes adherence to various ESG standards, robust grievance mechanisms, and collaborative initiatives with industry peers like Glencore. In a departure from the norm among Chinese mining companies, CMOC mirrors Western counterparts in its comprehensive adoption of general ESG standards. The explanation for this situation is likely to be found in the growing pressure that the company received from both the new DRC government and global downstream companies in promoting more responsible production and trade of cobalt (Walsh-Pickering 2022).

The CMOC case contrasts with that of CNG, which adheres solely to LME requirements, among our identified ESG instruments. While a comprehensive study is warranted to delve deeper into the underlying factors, it is clear that distinct company characteristics contribute to this disparity. CMOC, an internationally-oriented private entity with global reach (including ownership of IXM, a Swiss-based trading platform operating in over 62 countries, which was acquired from Groupe Louis-Dreyfus in 2019), stands in contrast to CNG, a central state-owned company (under the State-owned Assets Supervision and Administration Commission) heavily involved in projects aligned with the Belt and Road Initiative (BRI). This comparison underscores how Chinese companies' adoption of ESG standards reflects varied patterns influenced by factors such as ownership structure, company size, and degree of internationalization. Larger private Chinese companies appear more inclined to apply a diverse set of ESG standards. The disparity in standards implementation among Chinese companies seems to be wider than the gap between Western companies in which instruments they apply. In other words, the number of standards applied differs significantly between Chinese companies, a situation less visible in the case of Western ones.

In sum, despite the differences among Chinese companies, several overarching trends emerge. Companies predominantly focus on applying three categories of ESG standards: "overall guidance," "standards as market requirements (market standards)," and "Chinese versions of standards." Notably, Chinese companies typically embrace standards that operate at the corporate level rather than the site-level. They also focus on the implementation of instruments

[7] CMOC Group's Tenke Fungurume mine was even the first to receive CopperMark certification in Africa in June 2024 (The CopperMark n.d.).
[8] See more details: https://en.cmoc.com/html/SustainableDevelopment/OurApproach/

broadly recognized, such as the OECD, LME, or LBMA, with the exception of the two Chinese Guidelines. However, it is evident that fewer Chinese companies have adopted key mineral-agnostic standards such as ICMM, IRMA, and MAC TSM in comparison to their Western counterparts.

Chinese ESG reports reveal compelling narratives and insights on rationales for adopting specific ESG standards. Primarily, companies emphasize that sustainability issues post serious risks to the companies, which is why Chinese companies apply ESG standards "*to reduce risk* and meet expectations of stakeholders" (CMOC, 2022: 8, emphasis added). This language underscores a focus on risk (or crisis) management as central to sustainability strategies. Second, companies align themselves with internationally recognized standards (i.e., "international best practices") to cultivate a positive *global reputation and brand* and enhance their market competitiveness. For instance, CMOC articulated in its ESG report a commitment to achieving "world-class ESG performance" to facilitate access to resources, markets, and financing (CMOC, 2022: 7).

In a similar vein, the Chairman of Zijin Mining acknowledged in his 2024 new year message the challenge posed by expanding global operations conflicting with Chinese management paradigms, or "the mismatch between its growing global footprint and confined Chinese way of thinking and management." To address this, the company, *as a globally major supplier,* emphasizes its sustainability efforts as recognized by international ESG rating agencies. In addition, he emphasized the company's resolution to enforce strong ESG policies and to "ensure anyone who undermines *Zijin's reputation* is held accountable" (Zijin Mining Group, 2023; emphasis added).

Moreover, the application of ESG standards by Chinese companies underscores a focus on downstream market actors. Several companies emphasize mounting pressure from heightened sustainability expectations among international stakeholders. Against this background, the CEO of CMOC highlighted the company's engagement in an ESG initiative for sustainable cobalt mining that "will give end users (i.e., EV consumers) greater confidence and consciousness when they consume the products."[9] Fourth, the adoption of ESG standards by Chinese companies is influenced by emerging regulations or legislation introduced by influential entities within the supply chain. For instance, CMOC notes that the company began applying the RMI RMAP (one of the "mineral agnostic standards") to its tungsten operations in response to conflict-mineral regulations introduced by the US and the EU in 2021 (CMOC, 2022: 48).

In sum, this comparison indicates several points in the space of ESG development, adoption, and implementation across jurisdictions. There are discernible patterns in the application of standards, with variations in the depth of implementation. While this study builds on a small sample of companies in each region, the findings point to important questions for future research

[9] More information is available at https://en.cmoc.com/html/2023/ProductStewardship_0730/55.html

about where in supply chains companies are prioritizing ESG efforts and the ramifications of these strategic decisions. Notably, Chinese companies exhibit a stronger focus on downstream stakeholders, while Western counterparts lean towards upstream considerations. This is particularly visible in the mobilization of mining-specific standards by Western companies, such as TSM, IRMA, and ICMM which address the technical requirements for responsible mining. In the Chinese cases, the mobilization of instruments is mainly aimed at reassuring customers of good practices throughout complex supply chains.

Certain standards, as is the case with the two CCCMC Guidelines, state they are exclusively for Chinese entities and are built upon the existing global standards, challenging the notion of China attempting to threaten global rules and regulations. Despite differences in discourse, there is a convergence in language and messaging across Chinese and Western companies. The size and sector of a company appear to influence its approach to ESG standards adoption, with larger entities often demonstrating more comprehensive initiatives. This echoes two grounded aspects—first larger companies are more prone to risk exposure for themselves and their clients and second, implementing responsible sourcing practices is costly and more accessible to larger companies. Legitimacy in the eyes of international audiences and consumers drives companies to present themselves as global players, emphasizing their commitment to sustainability. The use of multilingual reports underscores efforts to engage diverse stakeholders effectively. With growing concerns surrounding the un-sustainability of the green transition's model of extractivism in critical minerals such as cobalt, copper, lithium, or nickel, mining companies globally have taken the stance to provide more information on the conditions of extraction and trade. In this analysis, we do not assess the quality or appropriateness of these disclosures but argue that the mobilization of standards recognized by the industry, governments, and (to a certain extent) external stakeholders, is a direct response to supply chain actors' requirements, customer pressure, and investors risk-averse behavior. Ultimately, while there are distinct nuances between Chinese and Western companies in their ESG endeavors, the overarching goal of enhancing sustainability and meeting stakeholder expectations remains a common thread that transcends geographical boundaries.

VI. Conclusion

Global efforts to reduce fossil fuels dependence are ironically leading to increased resource extraction globally. Supply chains spanning the world provide raw (or first treated) ore to transformation plants before entering the production of final 'green' products aimed at mitigating the effects of emissions. Through this new "volt rush" (Sanderson, 2022), in which brand companies are increasingly subjected to consumers' pressure on ESG practices, a flurry of standards have been defined to accompany a responsible and sustainable transition. In this article, we analyzed 13 internationally-accepted and well-used instruments that respond to these concerns, and their implementation by Western and Chinese companies.

The binary of Western and Chinese mineral producers, while useful for the purpose of this study, is one of political narratives. Alongside shedding light on the selection, use, and implementation of ESG production and trade instruments, we also underscore that breaking this binary is critical to understanding sustainability practices and discourse worldwide. Guidelines, standards, and framework are in many ways derived and used in similar fashions by both company categories and are often bound by geographical (e.g. MAC TSM used in Canada), material (e.g. CIRAF used in the cobalt sector), and political (e.g. CCCMC guidelines used by Chinese companies in lieu of OECD) consideration. However, the content of these instruments is largely related, with cross recognition and other cooperation mechanisms highlighting their interoperability. In all, it appears that the use of these instruments is aligned with geopolitical concerns (e.g. sourcing in specific jurisdictions etc.) and grounded economic matters (e.g. size of the companies etc.).

Nevertheless, while Western companies have a history of engagement with production and trade standards, the implementation of such instruments by Chinese companies is more recent and mirrors the leading space China occupies in the critical minerals sphere. Chinese companies and institutions recognize the importance of ESG principles and socio-environmental standards across industries for reasons of reputational risks, increased country-level standardization, and because they often form joint enterprises and public private partnerships with non-Chinese companies abroad. In this context, however, the emphasis on Chinese-developed instruments for Chinese companies, as outlined in CCCMC Guidelines, challenges the ongoing debate on whether China is striving to become a new global standards-setter threatening the existing global CSR rules and reflects China's gradual learning by doing approach. While this topic warrants more in-depth exploration, the prevailing political tensions surrounding Western-China rivalry seems to inform many of these analyses. In response, we suggest highlighting the autonomy and agency of Chinese companies as they experiment with responsible sourcing standardization, in contrast to their Western counterparts that rely on instruments developed within their own jurisdictions.

We propose several avenues for future research. First, more attention needs to be paid to the notion of internationalization and localization. While it seems that internationally oriented firms apply a wider and more complex set of standards, this finding requires further corroboration and elaboration. Second, we focus exclusively on industrial mining companies, and in the context of a booming artisanal sector crucial for the low-carbon transition. However, an analysis of the differential implementation of standards by mining companies purchasing these materials should be conducted. For instance, the case of Huayou Cobalt's subsidiary, Congo Dongfang Mining in the DRC exemplifies this trend. Third, further research should encompass the broader supply chain, including transformation companies. Finally, a valuable area for social science research lies in exploring the role of standardization and more broadly what Strathern (2003) describes as *audit culture* and its role in socio-economic contexts. More critical evaluations of these standardizing instruments are essential to evaluate their efficacy in providing accurate

information and fostering positive impacts at extractive sites and across minerals supply chains and production networks.

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