Energy Research & Social Science 105 (2023) 103284

Contents lists available at ScienceDirect

Energy Research & Social Science

journal homepage: www.elsevier.com/locate/erss

Original research article

Prospects for American cobalt: Reactions to mine proposals in Minnesota and Idaho

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ARTICLE INFO

Keywords:
Cobalt
Critical minerals
Energy transition
Conflict
Social acceptance
Stakeholder

ABSTRACT

Cobalt is a critical mineral for electric vehicles and the transition to renewable energy. There is increasing interest in developing U.S. production of cobalt, given that 70 % of mine production is in the Democratic Republic of Congo and 76 % of refinery production is in China, provoking geopolitical, supply chain, and environmental, social, and governance concerns. This paper focuses on the two leading prospective regions for U.S. cobalt production, in Minnesota and Idaho. Our central aim is to understand why reactions to mining proposals have been divergent, with polarized, intractable debates that have stalled projects in Minnesota while proposed mines in Idaho have advanced with minimal controversy. We summarize the geology and mining methods of each project before analyzing similarities and differences in responses, organizing our analysis around facets of environment, identity and legitimacy, politics, and economy. We find that many of the same dynamics are at play, differing in intensity and extent rather than being fundamentally distinct. The sites share many characteristics, including history of mining, proximity to wilderness, and economies rooted in both mining and recreation. Differentiating factors include the proximity of a large urban constituency in Minnesota with no parallel in Idaho, and smaller scale of mining proposals in Idaho.

1. Introduction

This paper compares two areas in the U.S. where proposed new mines would produce significant amounts of cobalt. Cobalt is used in batteries for electric cars and other devices, making it critical for electrification and the transition to renewable energy. In central Idaho's "Cobalt Belt," multiple projects focus on cobalt as the main product. In northeast Minnesota, multiple copper-nickel mines would produce cobalt as a byproduct, though in quantities rivaling or exceeding the cobalt mines in Idaho. The case study areas were selected because of their importance and unique characteristics. Minnesota's cobalt resources are the largest in the U.S., accounting for 65 % of the estimated national total [1]. Idaho ranks fifth with 6 % of the national total but is one of the only U.S. locations with projects focusing on cobalt as the main product.

The two case study sites share numerous characteristics, including long histories of mining, significant mining in the present, rural settings with proximity to wilderness areas, and significant recreation and amenity-based economic activity. Considering the numerous similarities, reactions to new mine proposals in the two sites have been remarkably distinct. The Minnesota mines have been enveloped in intractable debates centering classic environment versus employment themes, with mobilized constituencies on both sides. In Idaho, reactions have been much more muted, and positions appear more flexible, with dialogue and signs of compromise. This paper explores the Minnesota and Idaho projects to understand these divergent reactions. We use a socio-technical approach, first examining the geology and mining methods of each proposed mine in Section 3, before unpacking the reactions and debates surrounding them in Section 4. We contend that a convergent, interdisciplinary approach is necessary to analyze the full complexity surrounding mining, particularly in this moment of rapid expansion and renewed focus on the sector.

1.1. Cobalt and energy transition

Demand for cobalt has surged in recent years due to its role in battery technologies, and the demand is expected to continue growing as

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https://doi.org/10.1016/j.erss.2023.103284
Received 22 June 2023; Received in revised form 5 September 2023; Accepted 6 September 2023
Available online 25 September 2023

renewable energy and electric vehicles become more widespread. The Democratic Republic of Congo (DRC) continues to be the leading producer of cobalt, providing nearly 70 % of global production in 2022 [2]. Cobalt mining in the DRC is often linked with concerns over responsible sourcing, poor working conditions, environmental and community health degradation, labor exploitation, displacement, and violent conflicts [3–5]. Furthermore, the cobalt industry relies heavily on China for refining, which accounted for 76 % of the global cobalt refining production share in 2022 [6].

In addition to environmental, social, and governance (ESG) risks, the supply risk of cobalt also is high because it is often mined as a by-product of copper and nickel. As a result, literature on cobalt mining focuses on supply risks [7,8], geopolitics [9,10], and ESG risks [8,11]. Furthermore, many developed and emerging economies, including the United States, will likely face heavy import dependence in the coming years [12]. Vikström [13] argues that since 2010, mineral supply has become increasingly politicized, primarily attributed to the Global North's reliance on mines in the Global South, coupled with the rising demand for minerals. Additionally, producing countries aim to capture the benefits from the resource boom, while importing countries express reservations about investing in politically fragile nations despite concerns over resource availability.

In response to concerns over reliable and responsible supply, governments and companies have pursued a number of responsible sourcing initiatives for cobalt from the DRC, with mixed results [14,15]. Automotive industries and other advanced technology manufacturers, such as smartphone and laptop manufacturers, are attempting to secure long-term cobalt supplies through various channels [9]. The U.S. government is increasingly interested in securing domestic supplies of critical minerals, including cobalt [16]. Challenges are not limited to domestic mine production, as processing and refining capacity is also severely limited, with high overseas dependence [16].

1.2. Mining debates and stakeholder dynamics

Discussion of domestic sourcing for cobalt and other critical minerals often focuses on geology, exploration, and processing challenges. While these are undoubtedly key, perhaps the most important factors are social acceptance and regulatory / permitting challenges.

The need for critical minerals is often framed in the context of transitions to low-carbon and renewable energy systems in response to climate change [12]. This creates new stresses and risks on supply chains and development trajectories in an increasingly interconnected world [7]. Already, tensions are apparent between the need for *rapid* energy transitions and the need for *just* energy transitions [17]. Furthermore, the very notion of "critical" is contested, as the projected need for cobalt and other minerals varies widely depending on model assumptions, including the degree of acceptable or even desirable disruption of the economic, environmental, and social status quo [18].

The broader literature on mining conflict and social dynamics of the extractive industries provides insights to frame the discussion of proposed mining for critical minerals. Often, conflicts emerge when economies clash – that is, when the mining economy is seen to jeopardize other livelihoods; when communities feel unable to choose their own development paths; or when distrust of company and/or government undermines relations [19]. Mining conflicts can take many forms, from fundamental resistance to negotiation around the margins, to subordination and dependency [20].

Within the extractive industries, conflict is often discussed in terms of social license to operate (SLO) [21] and related notions like corporate social responsibility (CSR) and ESG. These approaches have been critiqued for centering corporate needs, focusing on risk management, and manipulating participation to maintain power and control [22–24]. Some critiques of social license and related concepts center on determinations of who counts as a stakeholder [25]. Defining areas of influence and communities of interest becomes an active terrain of contention [26]. Understanding this broad range of factors is paramount for making sense of responses to and dynamics around mining projects proposed under the umbrellas of energy transition and critical minerals.

2. Methods and data

This paper applies a comparative case study approach. The Minnesota cases have been subject of substantial research and writing, allowing us to rely on secondary academic and popular sources. No prior academic publications have analyzed cobalt mining in Idaho from a social science perspective. Thus, the Idaho case draws from primary data collection, using a workshop and interviews in addition to secondary sources and popular media. Throughout the first quarter of 2023, we held biweekly meetings with leaders of four local economic development agencies in central Idaho, culminating in co-hosting a workshop about local mining. The full-day workshop in April 2023 had participation from representatives of eight locally active mining companies, the Idaho Geologic Survey, and Idaho National Lab, in addition to the local economic development organizations. We complemented the workshop data with three in-depth interviews with Idaho stakeholders between March and June 2023. Ethics review for human subjects research was performed through the Colorado School of Mines.

3. Study sites – geology and mining description

This section provides a brief overview of the geology, ore characteristics, mining methods, and project summaries for each mine. This information helps contextualize the analysis of reactions in Section 4, as the physical and technical characteristics interact with social, economic, and other factors. The mineral deposits and proposed mines in Minnesota and Idaho share many characteristics, including the association of cobalt with copper and/or nickel, and the presence of sulfide minerals that create the potential for acid rock drainage (ARD). There are also important differences in mining methods, size of the ore bodies, and grades of cobalt and other minerals. Fig. 1 summarizes key characteristics. Fig. 2 shows the project locations and key contextual factors for Minnesota and Fig. 3 for Idaho.

3.1. Minnesota

Minnesota hosts several magmatic sulfide deposits containing nickel, copper, cobalt, and platinum group elements. Most of the known deposits are within the Duluth complex, one of the world's largest layered mafic intrusions. The entire Duluth complex is thought to contain 8 billion tonnes of ore grading about 0.2 % copper and 0.1 % nickel, alongside lower grades of platinum group elements and cobalt. Mineralized zones in the Duluth complex are irregular, following the same trend as the Biwabik Iron Formation that defines the Mesabi Iron Range. Similar mineralized zones also occur in the Tamarack intrusive complex in central Minnesota, as well as the Yellow Dog intrusive complex in northern Michigan. In these deposits, the copper-nickel ore bodies occur as sheet-like layers of massive sulfide minerals within the dipping stack of mafic intrusive rocks. The ore minerals include pentlandite ($(Fe,Ni,Co)_9S_8$), chalcopyrite ($CuFeS_2$), cubanite ($CuFe_2S_3$), and pyrrhotite ($Fe_{1-x}S$). The deposits are hosted in mafic to ultramafic igneous rocks.

3.1.1. Twin metals - Maturi

The Maturi deposit is located between the towns of Babbit and Ely, on the northwest side of Lake Superior, exposed at the surface near Birch Lake. The deposit extends under the Boundary Waters Canoe Area wilderness (BWCA), though the surface footprint of the proposed mine would be outside the BWCA and the mine would not extend under Birch Lake. The mine *would* be within the Rainy River watershed, upstream of the BWCA.

The Maturi deposit is under consideration for development by Twin Metals Minnesota, a subsidiary of the Chilean copper mining company

Company – Deposit	Mining method	Cobalt content estimates	Deposit size and grade estimates	Projected mine life
Twin Metals – Maturi (Minnesota)	Underground	18,000 tonnes contained Co	163 million tonnes of ore (estimated production) averaging 0.011% Co	25 years
PolyMet – NorthMet (Minnesota)	Open pit	44,520 tonnes contained Co	636 million tonnes of ore (measured & indicated) averaging 0.007% Co	20 years
Talon – Tamarack (Minnesota)	Underground (preliminary)	4,300 tonnes contained Co	8.6 million tonnes of ore (indicated) averaging 0.05% Co	undefined
Jervois – Idaho Cobalt (Idaho)	Underground	23,000 tonnes contained Co,	5.24 million tonnes of ore (measured & indicated) averaging 0.44% Co	7 years
Electra – Iron Creek (Idaho)	Underground (preliminary)	8,600 tonnes contained Co	4.4 million tonnes of ore (indicated) averaging 0.19% Co	undefined

Sources: Twin Metals mine plan of operation [27]; PolyMet technical report [28]; Talon resource report [29]; Jervois annual report [30]; Electra annual report [31].

Fig. 1. Characteristics of cobalt mining projects.
Sources: Twin Metals mine plan of operation [27]; PolyMet technical report [28]; Talon resource report [29]; Jervois annual report [30]; Electra annual report [31].

Antofagasta PLC. Twin Metals has measured and indicated resources of 1.3 billion tonnes at 0.57 % copper, 0.17 % nickel, and 0.011 % cobalt, in addition to 1.2 billion tonnes in the inferred category [32]. Twin Metals proposed to mine the Maturi deposit using underground methods, from about 400 ft to 4000 ft below the surface, with a twenty-five-year mine life [27]. The company planned to construct a crusher, mill, and flotation plant on site to produce Cu and Ni sulfide mineral concentrates, which would be shipped to an offsite refinery. The company's proposed environmental controls include using waste rock and tailings to backfill the mine, dry stacking tailings, and recycling process water for zero discharge [27].

The project went into environmental review in 2019, and the company was planning to apply for permits to develop the mine. In the meantime, the project has been at the center of a legal battle over the mineral leases. The mineral leases for the project were revoked in December 2016 at the end of the Obama administration, re-awarded during the Trump administration, and then revoked again in early 2023 due to the U.S. Department of Interior's issue of a 20-year mining moratorium on 225,000 acres adjacent to the BWCA, including the Maturi area.

3.1.2. PolyMet – North Met; Teck – Mesaba; NewRange

The NorthMet and Mesaba deposits are located between the towns of Babbit and Hoyt Lakes, about 10 miles southwest of the Maturi deposit. They are outside of the BWCA / Rainy River watershed and outside of the 2023 mining lease withdrawal, thus currently eligible for mining. The deposits are geologically similar to Maturi, consisting of dipping sulfide ore bodies hosting copper, nickel, cobalt, and platinum group elements.

The NorthMet deposit has been evaluated for development by PolyMet Mining, a Minnesota-based company whose chief asset is the NorthMet deposit. The company's majority shareholder is Glencore, one of the world's largest mining companies, headquartered in Switzerland. The NorthMet deposit has a measured and indicated resource of 636 million tonnes at 0.252% copper, 0.075% nickel, and 0.007% (70 ppm) cobalt, of which 262 million tonnes are proven and probable reserves. The deposit hosts an additional 400 million tonnes in the indicated category [28]. PolyMet previously proposed to mine NorthMet by open pit for a total depth of 700 ft. Production would be about 11 million tonnes per year, with a 20 year mine life. Waste rock would be used as backfill in the pit. Ore would be sent by rail to a nearby former taconite

Fig. 2. Minnesota project locations and key contextual factors. Map by first author.

plant to produce concentrates. Tailings would be stored alongside old taconite tailings in the tailings storage facility at the site.

The NorthMet project received the permit to mine from the Minnesota Department of Natural Resources in 2018 [33], but two recent decisions have reopened permitting issues. In June of 2023, the Army Corps of Engineers revoked a Clean Water Act permit, stating that it "does not ensure compliance with the Fond du Lac Band of Lake Superior Chippewa's water quality requirements" [34]. In August of 2023, the Minnesota Supreme Court unanimously ruled that the Minnesota Pollution Control Agency (MPCA) had improperly excluded concerns from the U.S. Environmental Protection Agency in their review of the mine. The court required the MPCA revise their process to consider the US EPA comments, though the court described this new review as "narrowly tailored" rather than a complete reopening of the process [35]. At the time of writing, it was unclear whether these decisions would ultimately halt the project or be resolved.

The Mesaba deposit has been explored by Teck Resources Limited, Canada's largest diversified mining company. Mesaba hosts 2,002 million tonnes in the measured and indicated category at 0.428% copper, 0.102% nickel, and 0.0076% (76 ppm) cobalt, with an additional 1,291 million tonnes in the inferred category [36]. Teck previously proposed to mine Mesaba by open pit, although the project is in earlier stages than NorthMet.

In 2023, PolyMet and Teck partnered in a 50/50 joint venture to develop the NorthMet and Mesaba deposits, under the company name NewRange Copper Nickel. The NewRange website states that it is pursuing similar operational designs to those described above and claims the company will be "the first to commercially mine copper, nickel, cobalt and other platinum group metals from the Duluth complex" [36].

3.1.3. Talon - Tamarack

The Tamarack deposit is located about 50 miles west of Duluth. The site is south of Maturi, Mesaba, and NorthMet, in the Mississippi River watershed. The Tamarack deposit is geologically similar to the deposits described above, albeit with higher metal grades, and it is hosted in a separate intrusive complex.

Talon Metals, headquartered in the British Virgin Islands, is in a joint venture with the Australian mining company Rio Tinto to develop Tamarack. It has an indicated resource of 8.6 million tonnes at 1.7 % nickel, 0.92 % copper, and 0.05 % cobalt, as well as an inferred resource of 8.5 million tonnes at lower grades [37]. The company is currently evaluating the potential for underground mining of the deposit and was selected by the U.S. Department of Energy to receive $114 million from the Bipartisan Infrastructure Law to construct a battery materials refinery [38]. They propose to site the refinery and tailings storage at a brownfield location in North Dakota. The facility would process ore shipped from Tamarack as well as other U.S. mines. Talon has also entered into a six-year nickel supply agreement with the electric vehicle manufacturer Tesla.

3.2. Idaho

The Idaho Cobalt Belt is one of the few locations in the world that could be prospective for main-product cobalt production. Cobalt is usually produced as a byproduct of nickel mining (e.g., in Minnesota and Michigan) or copper mining (e.g., in the Democratic Republic of Congo and Zambia) [39]. Although the deposits in Idaho contain both copper and cobalt, cobalt is the main product target. About 45 known occurrences of mineralization in the Idaho Cobalt Belt occur as semi-massive

Fig. 3. Idaho project locations and key contextual factors. Map by first author.

zones and disseminations of sulfide minerals, including cobaltite (CoAsS), cobaltiferous pyrite ($(Co,Fe)S_2$), cobaltiferous arsenopyrite ((Co,Fe)AsS), and rare catterite (CoS_2) - vaesite (NiS_2) minerals [16]. The main copper mineral is chalcopyrite ($CuFeS_2$). The deposits are hosted in metasedimentary rocks including siltites, quartzites, and argillites.

3.2.1. *Blackbird*

The Blackbird district was mined at various intervals between 1893 and 1982, from several different mine sites [40]. Mining occurred by open pit as well as underground operations by several different companies. Commodities recovered included cobalt, copper, and gold, with an estimated cumulative production of 19,700 t of ore [41] and an estimated 4.8 million tonnes of waste rock left on the site [40]. Acid mine drainage from the site resulted in a Superfund designation, and reclamation activities took place between 1982 and 2002.

3.2.2. *Jervois - Idaho Cobalt Operation*

The Idaho Cobalt Operation refers to a site in the Blackbird district within the Idaho Cobalt Belt, currently operated by the Australian company, Jervois Global. The site hosts two ore deposits, Ram and Sunshine, which contain measured and indicated resources of 5.2 million tonnes at 0.44 % cobalt and 0.69 % copper, as well as inferred resources of 1.6 million tonnes [30]. The mine has been permitted, and underground mine development began in late 2022, resulting in 27,000 t of ore that are ready to be processed. The design is based on a seven-year mine life. Most of the waste rock would be used as backfill in the underground excavations, with the remaining 30 % stored on the surface. The company constructed a tailings and waste rock storage facility, as well as an on-site mill to crush and grind the ore and produce a sulfide mineral concentrate by flotation. The company purchased a Ni-Co hydrometallurgical facility in Brazil and is refurbishing it to process Idaho ores [30]. In March of 2023, the company placed the operations on hold due to low cobalt prices, ceasing production and leaving only a skeleton staff on site. Simultaneously, Jervois is intending to prepare a Bankable Feasibility Study to assess construction of a cobalt refinery in the U.S.

3.2.3. *Electra - Iron Creek*

The Iron Creek deposit is located southeast of Blackbird and the Idaho Cobalt Operation, about 20 km from the town of Salmon, Idaho. The project is in advanced exploration stages. The Canadian company Electra Battery Materials (formerly known as First Cobalt Corporation) has identified an indicated resource of 4.4 million tonnes at 0.19 % cobalt and 0.73 % copper and an inferred resource of 1.2 million tonnes [31]. The company has been evaluating an underground mining scenario, with on-site production of mineral concentrates and on-site tailings storage. The company's main asset is a hydrometallurgical facility in Ontario, Canada that was previously used to process difficult ores including those containing cobalt and arsenic. Electra intends to retrofit the facility to produce cobalt and nickel sulfates, Ni-Co hydroxides,

lithium carbonate, and graphite by processing ores from Idaho and other sites, as well as recycling black mass from batteries [42]. The company has been slated to receive about C$20 million from the Canadian government toward this goal. Expected costs for refurbishing the plant have doubled to $121 million USD, and the company now states that it is considering selling some or all of its assets or developing strategic partnerships [42]. In the meantime, the Idaho exploration efforts have slowed, and the company has not stated whether it intends to continue pursuing mine development at Iron Creek.

4. Analysis – reactions to mining proposals

4.1. Overview

The contexts in Minnesota and Idaho share many important similarities. First, mining has been a major part of local culture and economies in central Idaho and northeast Minnesota for many decades. In central Idaho, mining activity is diverse, including historic and active mines targeting gold, silver, copper, molybdenum, cobalt, and other metals. In northeast Minnesota, iron mining has been a major industry for more than a century and remains significant, leading to the area's nickname, the Iron Range. Cobalt production, as a byproduct of copper-nickel mining, would be new for the region. Second, proposed mining sites in Idaho and Minnesota both border wilderness areas, which are federally designated roadless areas set aside for recreation and ecological conservation. Minnesota's Boundary Waters Canoe Area Wilderness (BWCA) is generally considered the most visited of all U.S. wilderness areas, famous for canoeing in its lakes and rivers. The Twin Metals site is about two miles from the wilderness, upstream within the Rainy River watershed which feeds the BWCA. The PolyMet and Talon sites are farther from the BWCA, in watersheds not connected to the wilderness. Idaho's Frank Church-River of No Return Wilderness (FCRNR) is the largest contiguous wilderness in the U.S. Lower 48 and is famed for remote, rugged terrain and whitewater rafting on the Salmon River. The Jervois site is about three miles from the wilderness boundary, and both Jervois and Electra sites are within the Salmon River watershed.

Although the sites share many characteristics, the reactions to proposed mining related to cobalt have been distinct. Minnesota has been the center of a polarized debate over new mines while Idaho has seen relatively limited controversy.

In Minnesota, the dominant early reaction was local enthusiasm when a series of proposals for copper-nickel mining in the state's northeast emerged in the early 2000s. The region had depended on iron mining, but mining employment was in long-term decline. Copper-nickel mining presented an opportunity for revitalization that fit with the local history, culture, and economy [43,44]. According to Kojola and McMillan Lequieu's analysis [44], the dynamic began to shift when PolyMet's initial environmental impact statement (EIS) was rejected by the U.S. EPA in 2010. This brought significant negative attention to the case, and by the time the company submitted a new EIS in 2014 they were met with an organized opposition that marshalled tens of thousands of public comments. When Twin Metals ramped up activity around 2014, the already mobilized opposition expanded to challenge both mines [44].

A network of environmental, anti-mining, and recreation groups launched a campaign titled Save the Boundary Waters (STBW),[1] bringing together local, regional (Twin Cities), and national organizations. Opposition to the copper-nickel projects in turn spurred a pro-mining counter-mobilization. Mining, business, economic development, and union organizations formed a campaign titled Better in Our Back Yard (BIOBY) – its name a play on, and critique of, the perception that resistance to mining reflects a NIMBY (not in my backyard) position.[2] The dynamic mirrors other polarized debates over mining, with organized constituencies on both sides locked into their positions with little substantive dialogue or efforts to find common ground [45].

In Idaho, cobalt mine proposals have not faced significant, organized opposition. For example, the Jervois project was able to obtain all necessary permits in relatively smooth fashion. The project's draft EIS, filed by prior owners Formation Capital in 2007, received 90 % favorable comments and by 2009 Formation had all needed permits in place [46]. In sharp contrast to the Minnesota case, the "most vigorous and consistent protester" was a competing mining company rather than environmentalists or community members [46], a dynamic repeated in at least one other instance of regulatory interventions among mining competitors in Idaho's Cobalt Belt [47].

Cobalt mining proposals in Idaho have not been met with organized opposition, but this does not mean the projects are without controversy or debate. Indeed, it is important to bear in mind that lack of opposition is not the same as welcoming or full acceptance, and there are always diverse perspectives within a community [22,48]. A local leader described the reaction as "measured," with some people excited about new mining proposals and others apprehensive, but neither side going to extremes (Interview 14 June 2023).

To better understand the different reactions in Minnesota and Idaho, in the following sections we examine key aspects individually.

4.2. Environment

Environmental impacts are at the heart of debates around new mines in both states, but with different emphases. In Minnesota, the environmental debate centers on acid rock drainage (ARD) and is highly polarized. Mining companies and their supporters claim advanced techniques will mitigate all environmental concerns. For example, Twin Metals published a white paper highlighting several measures to reduce environmental impacts and address ARD risks [49]. They include removing most sulfide during processing, mining with underground methods to reduce surface impacts, using a portion of the tailings for underground backfilling, and limiting the time in which waste rock and ore are stored on the surface. They claim that substantial advancements have been achieved in addressing ARD over the past two decades and characterize opponents' fears as unfounded or misinformed.

Opponents call into question the adequacy of engineered solutions, mirroring broader critiques of techno-optimism [50], and often present the environmental threat posed by copper-nickel mining in existential terms. For instance, on their campaign website, Save the Boundary Waters (STBW) asserts that 100 % of copper mines experience spills or accidental releases, branding copper mines as "America's Most Toxic Industry." The threat from proposed mines like Twin Metals is not presented in incremental terms, but rather as an existential threat to the BWCA as a whole and by extension the recreation and amenity economy.

In Idaho, environmental concerns have not been absent, but mirroring the overall situation, have been more muted. Notably, cobalt mining in Idaho has led to some blurring of traditional boundaries. The Idaho Conservation League (ICL) – one of the state's leading environmental organizations, which got its start in a campaign against a different mine – is choosing to view cobalt mining proposals through a climate change lens. They still oppose many mining projects, including the Stibnite gold and antimony project, which has unsuccessfully attempted to claim environmental benefits and relevance to the energy transition. But recognizing the importance of cobalt for electric vehicle batteries and other uses, ICL has been willing to support cobalt mining, at least provisionally. As part of the environmental impact review process, in 2008 Formation reached an agreement with ICL to resolve objections and provide funding for local environmental projects [46].

[1] https://www.savetheboundarywaters.org.

[2] https://betterinourbackyard.com/.

Current owner Jervois has a similar agreement with ICL.

4.2.1. Scientific expertise

One key facet of the environmental debate, especially in Minnesota, is over competing claims to expertise and science. Both sides have leveraged scientific research and reports to support their claims. For example, scientific studies have been commissioned by environmental groups opposing mining, including broad reviews that question whether hardrock mining can ever avoid water pollution [51] and targeted studies on possible negative hydrologic impacts in Minnesota [52]. These sources are in turn leveraged in other scholarly work in opposition to mining [53].

The central issue of ARD in Minnesota is a prime example of competing claims to scientific legitimacy. Twin Metals benchmarks their proposal to mitigate ARD through dry stacking tailings, with reference to the standards set by an industry organization, the International Network for Acid Prevention. Twin Metals further notes that dry stacking has been endorsed by environmental NGOs including Earthworks and the Minnesota Center for Environmental Advocacy [49]. In contrast, STBW questions the long-term viability of dry stacking in wet climates, claims that dry sacking is not sufficient to prevent ARD, and notes that dry tailings can degrade air quality with fugitive dust, which may contain heavy metals, sulfur, and fine particulates [54].

The emphasis on scientific legitimacy and expertise responds not only to the broad environmental debate, but also to the specific demands of environmental review processes. A detailed study analyzing the state's public comment process for PolyMet revealed a strong tendency to valorize expert and scientific knowledge and disregard lay knowledge or simple statements of support or opposition, which were deemed non-substantive [55]. Notably, by far the largest share of comments deemed substantive came from environmental and tribal groups opposing the mine.

In Minnesota, where mining is highly contested, both sides have produced extensive scientific information to support their respective positions. The websites of mining companies and environmental groups contain a plethora of documents and information supporting their positions. In contrast, in Idaho, where mining is less contested, companies' websites tend to be simpler, with less information and fewer documents shared. There is not a comparable level of competition over scientific legitimacy, companies and opponents are not producing dueling commissioned reports or posting point-by-point rebuttals, as seen in Minnesota. In the Jervois / Formation case, the agreement struck between environmentalists and the company relatively early in the process likely influenced this outcome. Environmental groups have focused much of their attention elsewhere, seemingly satisfied with the resolution of earlier concerns. Under this dynamic, there is not active, public debate over specific scientific points or interpretations.

4.2.2. Responsibility

In the current context of interest in energy transition, mining companies and their supporters have actively embraced discourses of environmental responsibility. After decades of being excoriated over environmental concerns, the mining industry has jumped at the opportunity to position themselves as champions of the energy transition and responsible supply chains. The websites of the companies highlighted in this paper are replete with examples of discourses of environmental responsibility. NewRange (PolyMet successor) emphasizes its commitment to providing a "multi-generational supply of critical minerals that supports the North American clean energy transition," while Electra claims to contribute to the development of the "US-based EV materials supply chain." In parallel, Twin Metals highlights slogans such as "the metals we'll mine are the metals you use" and "the world demands more and more metals every day. The minerals we have in Minnesota can help supply this demand."

In addition, proponents valorize domestic mining as more socially and environmentally responsible than overseas production. This is particularly the case for cobalt, with the well documented labor and human rights abuses in the DRC painted in sharp contrast to U.S. labor and environmental standards. Mining supporters portray opponents as hypocrites for opposing mining close to home but tacitly accepting that it happens elsewhere instead, often under worse conditions [18]. They argue that strong environmental and labor protections in the U.S. ensure that mining will have to be responsible, and that in addition, proximity allows better monitoring and accountability. For example, Jervois claims to produce "the world's premier supply of ethically sourced, sustainably produced American cobalt" and highlights its reliable supply to customers, particularly in the face of geopolitical and other risks, emphasizing the importance of domestic production over foreign sources. Twin Metals explicitly stakes a claim to responsibility with their slogan, "Our mining is more than safe. It's responsible." They further assert that Minnesota has long been a global leader in stringent regulatory processes for natural resource development and modern mining, implying that if they can meet regulatory standards there, they must be responsible.

Critics have been unconvinced, contending that the mining industry's discourse of responsibility rings hollow. They criticize the industry for making claims of sustainability and responsibility but employing very shallow conceptualizations of these terms [56,57], which in turn forecloses potential for more transformative change [58]. This is interpreted as a form of greenwashing, as the mining industry opportunistically seizes the narrative around critical minerals and energy transition without changing many of their underlying practices or environmental impacts [18].

The general debates around discourses and claims of responsibility in mining have been particularly tense in the Minnesota context. For example, STBW rejects Twin Metals' claims of responsibility and environmental safeguards, labeling it greenwashing [59]. Academic critics express skepticism about the ways the Minnesota mining companies "embrace regulations and perform transparent expertise" [44]. In their analysis, this performative regulatory embrace is more about maintaining power and silencing critics than about improving practices.

These debates are not absent in Idaho but have not been contested to the same extent. Environmental groups like the ICL have been receptive to the idea that responsible mining is possible but are also wary of greenwashing and exaggerated claims of relevance to the energy transition, professing to apply a "healthy dose of skepticism" in evaluating companies' claims [60]. As noted above, the Stibnite project in Idaho, where the main product is gold, has tried to position itself as responsible mining, noting both their secondary production of antimony, a critical mineral, and their plans to restore and reclaim areas of the project site that are located in a polluted legacy mining site. The project has been opposed by environmentalists who pointedly contest the company's claims of environmental benefits, with the director of an opposition group stating, "the notion that it will take a mine, and mining dollars, to clean up this site is irrational" [61]. In this light, the tentative acceptance of Idaho *cobalt* projects does not reflect carte blanche for the mining industry, but rather a willingness by environmentalists to take a case-by-case approach to judging acceptable environmental impacts, and ultimately, responsibility.

4.2.3. Precedent

Precedent around environmental concerns is one of the areas in which opponents of the mining proposals in Minnesota have staked an absolutist position. They regularly claim that *all* sulfide mining is polluting and acid generating. Adopting a linked strategy, Minnesota lawmakers have proposed the adoption of a "prove it first" law (MN H.F. 1618, 2023), which would stipulate that a new sulfide mine can only advance if the company can identify a substantively similar mine that has been operational for 10 years and closed for 10 years without polluting. The law is modeled after a similar Wisconsin statute, which was in effect from 1997 to 2017. The Wisconsin law was successful in halting new mines, as no company ever filed to attempt to meet its

requirements [62].

Precedent and benchmarking are central to the design of prove it first laws, shifting the burden of proof to mining companies – and defining the rules of engagement in a manner advantageous to opponents. An analysis commissioned by Friends of the Boundary Waters Wilderness demonstrated the potency of a prove it first law, were it to pass in Minnesota. The report examined all mines that have been proposed or suggested as positive precedent and systematically argued that none met the prescribed standards – either because they would not qualify as substantively similar (different climate, not in the U.S., etc.), had not been in operation long enough or closed long enough, or were not interpreted as having a clean environmental record [62]. Under that interpretation, the author noted that the bill would be "essentially a 20-year moratorium on nonferrous sulfide ore mining," given the requirement for benchmarking 10 years operational and 10 years closed.

As seen in the preceding quote, the prove it first bill's framing differentiates between iron mining, which remains largely unopposed and tacitly accepted as non-problematic, and copper-nickel mining, which is framed as unprecedented. This differentiation between iron mining and copper-nickel mining is a fundamental characteristic of opponents' discourses. Copper-nickel mining is treated as uniquely problematic and distinct from the familiar iron mining. This differentiation centers on the potential for ARD generation from sulfide mining which is largely absent from iron mining in the region. In Idaho, most or all projects – current and historic – have potential for ARD generation. As such, no distinction seems to be made, with the new cobalt projects not treated as substantially different from other mining. The dominant perspective of baseline acceptance of mining extends to the new cobalt projects.

However, acceptance is never total, and important nuances exist within the Idaho case. The precedent and cautionary tale of the Blackbird cobalt mine looms large over environmental discussions. Cleanup of the Blackbird site has been a high-profile issue for decades, initiated in the early 1980s when the state sued the then owners. Eventually an agreement to co-fund cleanup was reached with multiple mining companies that had worked the site over the years [63]. By many standards, the cleanup has been a success – fish including salmon are back in Panther Creek and surrounding waterways that had been rendered lifeless by ARD and heavy metals [64]. An environmental leader we interviewed believed the proximity of Blackbird raises the bar for environmental responsibility as mining picks back up. "I think it's a good cautionary tale... Companies don't want to be known as the next Blackbird" (Interview 9 March 2023).

A local leader took a slightly different view of the Blackbird precedent, interpreting the success of the cleanup – bringing the Panther Creek fishery back to life – as alleviating fears by demonstrating that recovery is possible even after egregious environmental damage from mining (Interview 14 June 2023). Other local stakeholders have voiced similar perspectives, that environmental harm, while best avoided, is not always catastrophic or permanent [64]. This stands in sharp contrast to the discourse in Minnesota of an existential threat to the BWCA – as implied in the campaign's name to "*Save* the Boundary Waters." Even when voicing environmental concerns, Idaho stakeholders have tended not to frame the threat so broadly (Interview 14 June 2023).

The Blackbird mine also provides a cautionary tale for current discussions of the notion of "critical" minerals and extraordinary or expedited methods to obtain them. Blackbird's most active period was spurred by government subsidies and direct exploration assistance early in the Cold War when cobalt was considered a critical mineral for national defense. Changing government policy – the end of price supports because the cobalt stockpile was deemed sufficient – also led to the end of Blackbird's boom period [65]. The current Superfund site is a direct result of the earlier era of "critical" cobalt. A representative of Glencore, the multinational mining company that currently owns the Blackbird site and is part of the coalition of companies responsible for cleanup, stated in a media interview that part of the problem stems from "corners cut" in the name of critical needs in an earlier era [66]. Although environmental regulations and practices have become more stringent since the Cold War era, present debates about expediting critical mineral production should remain cognizant of precedents like Blackbird, to ensure they are not repeated.

4.3. Identity and legitimacy

Identity and legitimacy have been central elements in the discursive contestation surrounding copper-nickel mining in northeast Minnesota. Mining supporters present themselves as the legitimate local voice, against the foil of urban outsiders who prioritize recreational value and abstract environmental mores over the local community and economy. For example, board member profiles on the BIOBY website assert local identity and legitimacy by highlighting that members have lived and worked most of their lives in northeast Minnesota.[3] In contrast, the STBW / Northeastern Minnesotans for Wilderness board profiles stake a competing claim to identity and legitimacy by emphasizing long-standing ties to the BWCA and recounting transformative wilderness experiences.[4] With both sides claiming to speak for "the people" and protect the best interests of public land, Kojola describes these competing frames as "extractive populism" and "wilderness populism" [43]. The competing claims to legitimacy echo familiar debates around American public lands, pitting rural autonomy and local economies against conservation and the interests of a more broadly defined public, including urban residents and both nearby and distant publics.

A unique study in Minnesota, conducted at the popular State Fair, surveyed fairgoers to understand public attitudes toward copper-nickel mining. Though not statistically representative, the study confirmed the centrality of classic environment versus economy debates. Most respondents fell into one of these two groupings, which were in turn highly correlated with identity and political affiliation [67]. As they summarize, "whether an individual identifies northeastern Minnesota as the bastion of pristine water or natural resource extraction, this identity, often coupled with partisan leanings, is the best predictor of support for mining operations" [67]. The survey also demonstrated that the opposing campaigns of STBW and BIOBY are indeed reflective of leading perspectives among the public. In addition, the survey showed that Minnesotans not directly tied to the northeast region nonetheless have taken sides on the question of copper-nickel mining.

Opponents of mining in Minnesota also frequently mention the foreign ownership of Twin Metals, which is a subsidiary of the Chilean company Antofagasta, and PolyMet, whose majority shareholder is Swiss giant Glencore, seemingly seeking to discredit the proposals' claims to local benefits and concern. Mining opponents' use of nationalist discourse creates an interesting contrast to mining supporters and mining companies, who also employ nationalist discourses. Supporters' discourses focus on national security implications of critical mineral supply, concerns about supply chain responsibility, and assertion of superior regulatory control in the U.S. From each side, competing versions of nationalist discourse are employed in the fight for legitimacy [18].

In Idaho, questions of identity and legitimacy feature many of the same characteristics as in Minnesota, though pro-mining views are more dominant. In our workshop, miners from central Idaho painted environmentalists as outsiders, questioning their legitimacy in the local sphere (Workshop 25 April 2023). In two separate follow-up interviews, locals dismissed many environmentalists as new arrivals to Idaho who are trying to change the state, insisting that by far pro-mining perspectives dominate among the local population (Interviews 14 June 2023; 16 June 2023). Discussions in the workshop often centered on mining-versus-environment debates but focused on national scale policy concerns rather than specific local debates. Miners also repeatedly

[3] https://betterinourbackyard.com/bioby-board/.
[4] https://www.neminnesotansforwilderness.org/meet-the-board-1.

staked claim to legitimacy as land stewards, noting that they live in the areas where they mine, that they are hunters, fishers, and outdoors-people and do not want to harm any of those activities or places. They cast doubt on the legitimacy of the demands of environmentalists, claiming they were more about control and anti-mining bias than legitimate conservation concerns (Workshop 25 April 2023).

Many of the miners we heard from continued to think in terms of classic adversarial relationships between mining and environmentalists. Even signs of change, such as the agreement between Jervois and the ICL, provoked mixed reactions. Some miners were appreciative that groups like ICL were becoming more receptive in recent years, getting "in line" with the concept of responsible mining. Not everyone was convinced, though – some other miners took a cynical view of the cobalt projects "buying off" the environmentalists (Workshop 25 April 2023). These divergent reactions among miners reflected different views of the legitimacy of environmentalists; some maintained a combative mindset and sought to reject environmentalists completely, while others were receptive that environmentalists had a role to play and could be worked with under some circumstances.

4.3.1. Indigenous communities and tribal actors

Indigenous communities and tribal governments are important actors in both settings, staking claims to influence and legitimacy with varying degrees of success. Northeast Minnesota is home to multiple indigenous communities, including the Bois Forte Band of Chippewa, Fond du Lac Band of Lake Superior Chippewa, Grand Portage Band of Lake Superior Chippewa, and Mille Lacs Band of Ojibwe. Tribal governments and indigenous activists have been at the center of opposition [18]. In recent decades, indigenous communities and tribal governments have been able to intervene successfully in various cases around the region [68], including through submissions for the PolyMet public comment process [55]. The revoking of wetland permits for PolyMet in June 2023 were the result of Fond du Lac's opposition and the proposal's failure to meet their more stringent tribal water quality standards [69]. Talon Metals' proposed Tamarack nickel mine has been opposed by the Mille Lacs Band of Ojibwe over its potential impacts on water and wild rice.[5] Wild rice is a culturally and economically important native food that has been shown to be negatively impacted by sulfide pollution [67].

Despite growing influence in the region, it is important to recognize that indigenous groups have long faced discrimination and continue to suffer the effects of historic and current marginalization. The dominant imaginary of northeast Minnesota centers white identity and nostalgic representations of mining and logging, which contributes to erasure of indigenous residents and history, naturalization of expulsions, downplaying environmental injustices, and normalization of extraction [70]. Indigenous influence in the region's mining and environmental debates remains tenuous, as demonstrated by the backlash that followed tribal actions and legal victories in fisheries management [68].

Idaho's indigenous groups also have shown strong interest in mining and environmental concerns. The Shoshone-Bannock Tribes from Fort Hall Reservation have been important stakeholders and active participants in the restoration efforts around Panther Creek and the Blackbird mine. Regarding the new cobalt mines, in a media interview, a representative stated that the Tribes are not against mining in their historic homelands, but they do take a keen interest in ensuring environmental standards are upheld. He also drew a clear through-line from past injustices and displacement directly caused by mining, to ongoing concerns about marginalization, saying, "I have a problem calling it historical trauma, because it never stopped" [65]. The legacy of historic violence, with indigenous communities expelled from central Idaho beginning in the earliest settler mining periods, creates insidious impacts in the present. Because the Fort Hall reservation is a three-hour drive from the town of Salmon and the Cobalt Belt, indigenous communities are not always recognized as stakeholders.

[5] https://waterovernickel.com/.

4.4. Politics

Although many permitting processes are carried out with national agencies, state and local politics and policies can still have a large impact on mining. This reality is reflected in the Fraser Institute's annual survey of global mining executives regarding their perspectives of different jurisdictions (countries, states, provinces, etc.). Idaho has a strong pro-mining reputation, as evidenced by its ranking at the top of the report's Policy Perception Index in 2020 [71]. On the other hand, the mining industry increasingly perceives Minnesota as an unwelcoming jurisdiction. It was ranked second-last among included U.S. states for investment attractiveness in the 2021 edition [72].

Minnesota has a complex political history that is beyond the scope of this paper, but in recent years there has been a widening breach as northeast Minnesota shifted rightward, especially during the Trump election cycles, while the state as a whole experienced a resurgence in Democratic control, including capturing the governorship and both branches of state congress. Bills like the prove it first described above have greater chances of enactment under the current political reality. The leftward shift in state politics has also ushered in new administrative skepticism toward mining. For example, due to differences with the Trump administration, the state Department of Natural Resources (DNR) took the unusual step of performing a separate state-level environmental review for Twin Metals, rather than deferring to the national process [73]. This dynamic could become more commonplace if national proposals to fast-track critical mineral projects proceed, placing more importance on state and local processes [18].

Though operating at a greater distance, national politics have also significantly shaped Minnesota copper-nickel mining projects, as noted in Section 3. National politics have shifted around the Twin Metals project in particular: mining leases were revoked under Obama, reinstated under Trump, then the area was subjected to a 20-year mineral withdraw under Biden, with the leases re-revoked. The Biden administration has been critiqued for contradictory policy toward mining, which rings true in the Minnesota example [74]. On the one hand, the administration adopted a 20-year mining withdraw that seriously eroded the prospects of the Twin Metals project. On the other hand, the Biden Department of Energy has invested $114 million in Talon's Tamarack project. There appear to be significant unresolved debates within the administration about the balance between competing interests like energy transition, national security, economy and jobs, environmental justice, and traditional environmental conservation – and these internal debates are playing out in contradictory responses toward Minnesota mining proposals.

In Idaho, state and local politics are more closely aligned with the mining industry. Given the broad support for mining among politicians and the public, it would be "hard to imagine a mine getting denied here because of the social outcry," according to an environmental leader (Interview 9 March 2023). Instead, they described scope for more specific and limited environmental considerations – environmentalists and community members are able to pressure for solution of specific issues, rather than engaging in outright opposition to mining. In this regard, while broadly pro-mining, the state's politics do not provide carte blanche for the industry; there are also longstanding environmentalist political currents. Notably, resistance to proposed mining near Castle Peak – the same battle that gave the Idaho Conservation League its start – ushered in a period of greater restraint and environmental consideration in the 1960s and 70s [75]. State politics have moved farther to the right in recent decades, but conservation concerns remain part of the dynamic.

A cobalt debate from an earlier era illustrates the pragmatic approach to conservation in Idaho. The original designation of the Frank Church-River of No Return Wilderness, in 1980, hinged in part on a compromise over cobalt, negotiated by Idaho Senator and wilderness

namesake, Frank Church [76]. With an eye to possible future cobalt mining, the boundaries were drawn to exclude known deposits, and a "Special Mining Management Zone" was established within the wilderness [77]. Although these steps have not resulted in cobalt mining within the FCRNR, the historic compromise demonstrated less rigid politics around public lands and environmental conservation in Idaho, compared to Minnesota.

4.5. Economy

The terms of economic debate in Minnesota pit the mining economy against the recreation-amenity economy – two important sectors in the state's northeast. Iron mining has been an economic mainstay for a century, but employment has been in long-term decline, exacerbated by boom-and-bust cycles [43]. Copper-nickel mining is promoted as an opportunity to revitalize the mining economy, with its high paying jobs and strong multiplier effects. The perceived importance of boosting mining jobs helps explain the historic shift from contentious company-labor relations to their collaboration on the BIOBY campaign. Mining opponents argue that the new mines would jeopardize the recreation and tourism economy that is another mainstay in the region. Canoe outfitters, resorts, and other recreation companies have been prominent in the anti-mining campaigns.

Both sides have commissioned or leveraged research to bolster their economic claims. The Bureau of Business and Economic Research at the University of Minnesota-Duluth has conducted a series of economic impact studies of the mining industry in northeast Minnesota, in coordination with industry associations [78–80]. The reports underscore the importance of mining in the regional economy, based on higher-than-average wages, strong economic multipliers, and significant tax contributions. Based on surveys of mining companies, the most recent report projected copper-nickel mining employment to grow from just under 50 jobs in 2019 to approaching 500 in 2024 [80].[6] Mining advocates have explicitly argued that mining jobs are better than tourism jobs [67].

The STBW campaign commissioned outside economists to review the 2012 edition of the UMD study. They heavily criticized the methodology and premise, concluding that it led to "consistently inflated economic impacts" and ignored both economic and environmental trade-offs [81]. A subsequent report commissioned by Northeastern Minnesotans for Wilderness focused on perceived tradeoffs and argued that 5000 to 23,000 jobs could be lost if copper-nickel mining commenced, accompanied by revenue and property value losses, due to environmental harm that would undermine the recreation and amenity-based economy. Fundamentally, they argue that the amenity-based economy – recreation and tourism, but also less tangible things like attracting and retaining population due to amenities and quality of life – is the true driver of the northeastern Minnesota economy, rather than mining [82]. An independent academic study came to similar conclusions, modeling scenarios with and without the development of the Twin Metals mine and finding net economic effects would likely be negative, given boom-bust cycles in mining combined with harm to the recreation-amenity economy [83].

The economic debate centers on the perception of higher paid (but fewer) mining jobs versus more (but lower paid) recreation / amenity jobs, with the attendant impacts on the overall economy. The competing economic analyses diverge in part due to different decisions about scope, geographic range, baseline, and assumptions about multiplier effects and job creation pathways. For example, many of the pro-mining analyses consider a larger region, including Duluth, a small city that acts as the regional hub, while anti-mining analyses often consider a smaller region, excluding Duluth. Although these methodological differences help explain how the analyses can reach such varied conclusions, the fundamental debate hinges on underlying arguments about whether copper-nickel mining and recreation economies can coexist, which in turn hinges on environmental impacts.

In contrast to the heated economic debates in Minnesota, the cobalt mining projects in Idaho are generally not considered a threat to the recreation economy. A local leader described the mining sites as "like a pebble of sand" in relation to the vast recreational landscape, also emphasizing their remoteness – the Jervois site is a two-hour drive from the town of Salmon, mostly on dirt roads (Interview 14 June 2023). Another interviewee stated that the local mines, cobalt and others, are generally visible only when flying above them – they do not impact the recreation experience. Furthermore, they stated that hunting, fishing, and motorized recreation contribute more to the local economy than wilderness recreation, and the people engaged in these activities tend to be pro-industry and untroubled by mining (Interview 16 June 2023). For their part, environmental groups have chosen to prioritize conservation in other areas of the state, conceding that the cobalt projects are in areas that have long been "working forest" with numerous roads and legacy mining sites already dotting the landscape (Interview 9 March 2023). Thus, despite proximity to the wilderness, the Idaho sites are not perceived as a direct threat to the recreation and amenity-based economy, in contrast to the campaigns in Minnesota.

The dominant economic concern in Idaho instead centers on reliability. Local leaders and miners alike described the community as wary, having been "burned" in the past by the boom-and-bust cycles of mining (Interview 14 June 2023; Workshop 25 April 2023). At the time of the workshop, both Jervois and Electra had recently halted or dramatically scaled back local operations, putting the economic volatility of mining in stark relief. Additionally, the cobalt projects are relatively small, so community members recognized that any economic benefits would be modest (Interview 14 June 2023). The cobalt projects have already gone through multiple cycles of ramping up and slowing down, including multiple changes of ownership, further tempering local expectations and underscoring the theme of reliability (Interview 16 June 2023).

5. Discussion and conclusion

Proposed copper-nickel mining in Minnesota has faced determined opposition while cobalt mining proposals in Idaho have advanced with minimal controversy. At first glance the reactions could not be more different. However, upon closer inspection we found that many of the same dynamics are at play, differing in intensity and extent rather than being fundamentally distinct. The same fields of debate – environment, identity and legitimacy, politics, and economy – can be identified in both cases, and indeed are common across many extractive and environmental debates.

Our focus has been on describing the different responses and understanding the perspectives behind them. The limitations of the current study have not allowed us to definitively explain *why* these differences exist, but in closing, we propose some possible explanations, which could be areas for further study. Reflecting on the causes of differentiated responses, two key factors rise to the top.

First, the role of urban stakeholders. In the Minnesota case, support and opposition have important geographic dimensions; many opponents are urbanites, largely from the Twin Cities (Minneapolis and St. Paul), and many supporters are rural residents, especially Iron Range locals [18,43]. As noted in Section 4.3, this mirrors classic conservation and public land debates over local control versus interests of a broader public. The same dynamic of identity and legitimacy is also present in Idaho, as locals in both sites paint environmentalists as outsiders. The biggest difference seems to be the proximity of the Twin Cities, a major metro area with no parallel in the vicinity of the Idaho Cobalt Belt, and the affective ties between Twin Cities residents and the BWCA. The volume and intensity of engagement make urban voices impossible to

[6] This estimate, based on 2019 surveys, assumed one or both of the PolyMet or Twin Metals projects would be in production by 2024. Based on subsequent events, it is likely that neither will be operational by 2024 (if ever), so any significant boost in mining employment would be substantially delayed.

ignore, shifting the balance of power. Liberal state politics in Minnesota mirrored and magnified this dynamic, translating opponents' positions into policies and administrative approaches. In Idaho, the dominance of the local, supportive perspective was mirrored and magnified by the conservative state government.

Indigenous actors and tribal governments are important players in both contexts. In Minnesota, indigenous actors have been central in resistance to mining projects, and their positions and advocacy intersect with urban mining opponents, especially environmental justice organizations. More research is needed to understand the overlaps and dynamics between urban, environmental, and indigenous actors.

Second, the scale of operations is a potential factor in the divergent reactions. The mines in Minnesota are planned to be much larger – the ore reserves at PolyMet, the largest Minnesota project, are more than fifty-times those of Jervois, the largest Idaho project. As an environmental leader in Idaho noted, "it's easier from an environmental group standpoint to attain some comfort level with a small project" (Interview 9 March 2023). In both contexts mining is already visible on the landscape, but in Idaho the new mines have been perceived as "a pebble of sand" in a vast "working forest" landscape – in short, unimpactful. This has not been the reaction in Minnesota, with the scale of operations potentially an important factor – though undoubtedly one among various. Further research is needed to delve into the effects of operation scale on acceptance or opposition to mining and the importance of this factor relative to other dynamics and concerns. Similar questions could be analyzed regarding underground versus open pit mining methods.

Comparing the two cases also underscores a bitter economic irony. The largely uncontested Idaho projects are stalled for purely economic reasons, while the Minnesota projects, which have not faced the same economic struggles, cannot overcome environmental-social concerns. Local acceptance is not sufficient to advance the Idaho mining projects that even miners admit are economically "marginal" (Workshop 25 April 2023). Cobalt's designation as a critical mineral has not shifted the market forces that have long relegated it to byproduct status. This leaves Idaho communities that seem willing to welcome new mining – and that have the historical knowledge to understand the pros and cons entailed – waiting and watching, and it leaves the cobalt production status quo unchanged.

In Minnesota, on the other hand, opponents have been successful thus far in stopping or delaying copper-nickel mining, but difficult choices remain on the horizon. Within a context of climate change and energy transition, can or should they continue to oppose all copper-nickel mining in the state? And how do opponents (and regulators) prioritize between sites or weigh tradeoffs? Other commentators have noted fractures between those who prioritize conservation and recreation – focused on stopping Twin Metals – and those who prioritize environmental justice – focused on stopping PolyMet and/or Talon [43]. This reflects longstanding tensions within the environmental movement, as well as echoing specific challenges of tradeoffs between rapid and just transitions to low-carbon energy systems [17].

Declaration of competing interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: Elizabeth A. Holley reports financial support was provided by National Science Foundation.

Data availability

Data will be made available on request.

Acknowledgements

The work was funded by NSF Growing Convergence Research award #2120721 as part of the "Responsible Critical Elements" project. The authors thank the interviewees and workshop participants who made this paper possible. Thanks to Rod Eggert and Jordy Lee Calderon for collaborating on the workshop.

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