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Mine development times:
The US in perspective

Mohsen Bonakdarpour, Executive Director | mohsen.bonakdarpour@spglobal.com
Frank Hoffman, Consulting Associate Director | frank.hoffman@spglobal.com
Keerti Rajan, Consulting Director | keerti.rajan@spglobal.com

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For more information on this report, please contact:

Mohsen Bonakdarpour | Executive Director, Market Intelligence
mohsen.bonakdarpour@spglobal.com

Frank Hoffman | Associate Director, Market Intelligence
frank.hoffman@spglobal.com

Keerti Rajan | Director, Market Intelligence
keerti.rajan@spglobal.com

This study offers an independent and objective assessment of the time taken to develop a mine from discovery to production. Its focus is the US, which is compared with peers Canada and Australia. It aims to provide a full perspective of development times by considering both mines that have come online and those still in development.

The study was supported by the National Mining Association of the US (NMA). The scope of the study was agreed with the NMA but the Association did not provide data or substantive input to the report. S&P Global Market Intelligence is solely responsible for the analysis and conclusions in the report.

Project team

Executive-In-Charge

Mohsen Bonakdarpour | Executive Director, Market Intelligence
mohsen.bonakdarpour@spglobal.com

Directors

Frank Hoffman | Associate Director, Market Intelligence
frank.hoffman@spglobal.com

Keerti Rajan | Director, Market Intelligence
keerti.rajan@spglobal.com

Research and analysis

Kristyna Alexova | Consultant, Market Intelligence
kristyna.alexova@spglobal.com

Katarzyna Skrzypek | Senior Consultant, Market Intelligence
katarzyna.skrzypek@spglobal.com

Contributors

Kevin Murphy | Research Director, Commodity Insights
kevin.murphy@spglobal.com

Paul Manalo | Research Analyst, Commodity Insights
paul.manalo@spglobal.com

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Executive summary

Executive summary (1)

In this report, S&P Global Market Intelligence analyzes the time taken to develop a mine from discovery to production in the US, compared with peers Canada and Australia. We use our Metals & Mining database, which categorizes mine development consistently across geography and commodity.

- The US has the second longest mine development times in the world, at almost 29 years on average from first discovery to first production. Only Zambia takes longer (34 years). This US figure assumes that currently non-operating properties in the US – projects whose development usually began decades ago but have still not become productive – start producing by 2030.

- The development of a mine in the US is not only long and costly, it is unusually uncertain. While developing a mine in Canada or Australia can also take a long time, with respective average times of 27 and 20 years, those mines do reliably enter production. In the US, even if mines receive all required permits, they are subject to higher litigation risk. (Our data here is only indicative, but there are more mentions of litigation in US properties than in Canadian and Australian properties combined.) Uncertainty and litigation risk may explain why exploration budgets committed by investors to Canada and Australia over the last 15 years have been 81% and 57% higher than to the US.

- This difference is starker in the context of the US's endowments of the strategically important metals that will be needed for energy transition. The US's copper endowment (reserves and resources), for example, is comparable to those of Canada and Australia combined and sufficient to satisfy US demand for the foreseeable future. But for several major energy transition minerals – copper, lithium, nickel, and palladium – the US receives significantly less in exploration budget per metric ton of endowment than Canada or Australia.

- Mining accounts for larger shares of gross domestic product and employment in Canada and Australia so there may be more political will to bring projects online. Institutional architecture matters too: in all three countries both federal and state/provincial governments have some jurisdiction over mining permits. But in Canada and Australia there are dedicated ministerial offices for mining.

- Gold mines are developed the fastest, taking an average of 20.8 years globally. Copper – the 'metal of electrification', fundamental to the energy transition – is one of the slowest to develop, taking 24.1 years. The equivalent figures in the US are 24.2 and 31.8 years.

Executive summary (2)

- **Mines coming online in the US are the exceptions.** Since 2002 only three mines have come online in the US – but they are the exception rather than the rule. None of them are located on federal lands, where the permitting process is more complicated and litigation risk higher. For a full perspective of development times in the US and around the world, it is important to consider non-operating mines, i.e. those that are still in development. In the US there are another 10 of these.

- **The US is not achieving its mineral potential.** It has a huge and strategically important mineral endowment whose development is too long and ultimately too uncertain to attract the investment its peers receive. Without this investment the US will remain reliant on external sourcing for the metals critical to its energy transition.

- **Shortening development times in the US is a historic challenge.** The complexity of overlapping authorities, especially on the federal lands under which much of the US's endowment is located, may be as difficult to simplify as it is to navigate. But the global aspiration of net zero by 2050 provides a strong impetus. S&P Global has shown in recent research that US demand for key energy transition minerals is set to soar over the coming decade. Without exploiting its own endowment, the US will remain highly reliant on external partners – and vulnerable to deepening geopolitical rivalries.

Introduction

Introduction: Metals and the energy transition

The energy transition will boost demand for a wide range of materials as new infrastructure is built and new technologies are adopted. S&P Global research has established the scale of the challenge in sourcing these materials. In 2022 we calculated that the world will need to produce more copper – the "metal of electrification" – in the next 12 years than it had in the previous 120 years. In 2023, we showed that after the US's Inflation Reduction Act (August 2022; IRA), US consumption of lithium, cobalt, and nickel – the 'battery minerals' – would reach compound growth rates between 20 and 30% by 2035.

But this surging demand will extend to other metals too, as the world's energy systems are fundamentally changed. Among these materials are several 'critical minerals': currently 50 non-fuel minerals are listed by the US Geological Survey as "essential to the national or economic security of the United States." The IRA lists 50 applicable critical minerals, to which its content rules apply. Reliable sourcing of these minerals has become core to industrial strategy across major economies. Without them, the energy transition cannot be achieved.

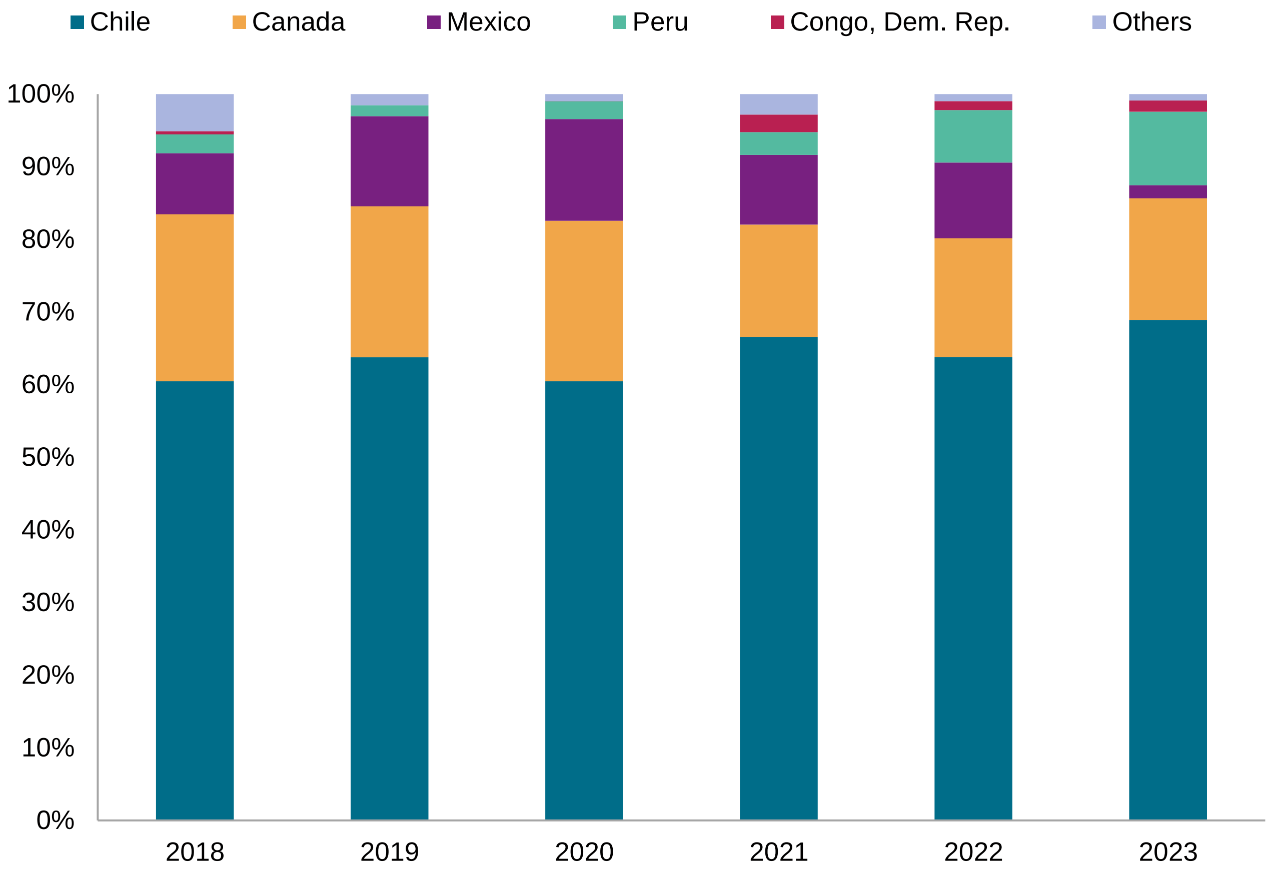
Introduction: Sourcing and geopolitics

Policymakers are keen to ensure supply chain security – and a key objective of the US's IRA is to 're-shore' or 'friend-shore' the extraction and/or processing of critical minerals. This strategic shift is closely related to intensifying geopolitical rivalry. Meanwhile businesses are concerned about the growing number of risks to their supply chain, including conflict and political violence, resource nationalism, and shareholders' concerns about the environmental and social impact of international supply chains.

But the US currently relies on other countries to meet its needs. Chile and Australia, for example, together account for almost three-quarters of globally mined lithium but this is mostly exported to China.

Even where a trade relationship is long established, the US is in competition with other buyers. Chile, for example, accounts for nearly 70% of US imports of refined copper. But Chile's exports of refined copper are huge. From Chile's perspective, the US buys only 20% of its exports; whereas China buys more than 40%. If Chinese and US buyers were to compete for demand for larger offtakes of Chilean refined copper, the Chinese buyers are likely to have greater bargaining power.

US imports of refined copper by share of trade partner



Data compiled Feb. 20, 2024.

Source: S&P Global Market Intelligence.

Introduction: Tapping the US endowment

Fortunately for the US, it has a vast mineral endowment – including in copper, lithium, and palladium (widely used in catalytic converters and fuel cells). There is, however, widespread recognition among US policymakers that the long times from first discovery to first production are a major impediment to tapping the US’s mineral endowment. The challenges vary depending on jurisdiction and are most acute on federal lands, where decisions must be sought from multiple authorities without a single, coordinating agency. And federal lands comprise almost half of the territory of the 11 western states – where that US endowment is concentrated.

A mine’s development is a resource-intensive undertaking in itself. First, there is the need to prove up the resource, which can take years and sometimes over a billion dollars. For mines on federal lands, a detailed plan of operations must be submitted to relevant federal agencies. If satisfied, they will issue completeness determinations (i.e. a complete plan of operations or a complete permit application has been submitted). This also often takes years. Then, required processes under the National Environmental Policy Act that produce an environmental impact statement can begin, which the government estimates takes approximately four years. This stage can include several government agencies, including the Bureau of Land Management, the Forest Service, the US Army Corps of Engineers and the Fish and Wildlife Service. These agencies, whose resources are themselves often constrained, may ask for further revisions of the environmental impact statement, adding to total development time.

This long and costly process gives rise to significant uncertainty and litigation risks, narrowing the US opportunity to secure its supply chains and energy transition.

Introduction: Discovery to production

In this analysis, we explore the time taken to develop a mine from discovery to production for mining projects in the US and overseas over recent decades. Our targets are simple:

1

How long does it typically take to develop a mine around the world?

2

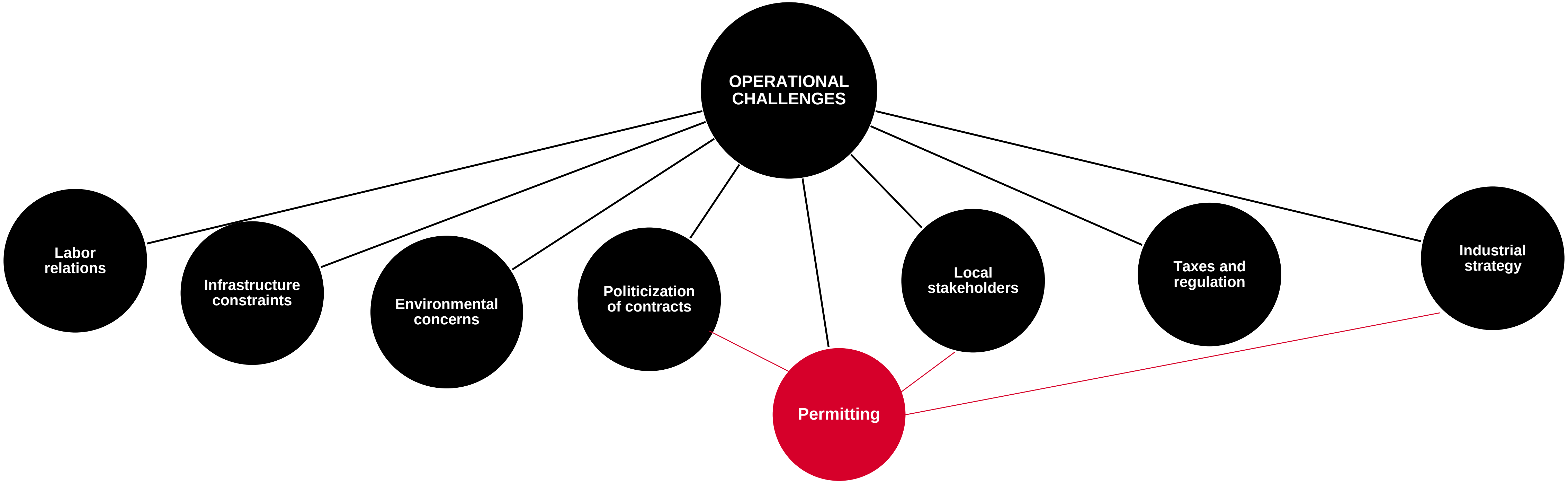
How long does it take to develop a mine in the US?

3

How does the US compare with advanced economy peers, Canada and Australia?

Introduction: Canada and Australia as US peers

In this analysis, we take Canada and Australia as US peers for comparison. S&P Global identifies eight recurring themes across 16 key countries for mining and/or refining. Permitting, a key reason for the long times from discovery to production, is an overall challenge, encompassing many of the others, including environmental concerns, engagement with local stakeholders, and national industrial strategy. These eight themes unsurprisingly apply in varying degrees around the world.



This variance is smaller, however, across the US, Canada, and Australia. Like the US, those countries have substantial mineral endowments. They adhere to high environmental standards and their governments are sensitive to the concerns of indigenous populations. They enjoy well-developed infrastructure and generally benign industrial relations. They are also multi-level governments, with federal and state/provincial executives.

Development times

Development times: Development times around the world

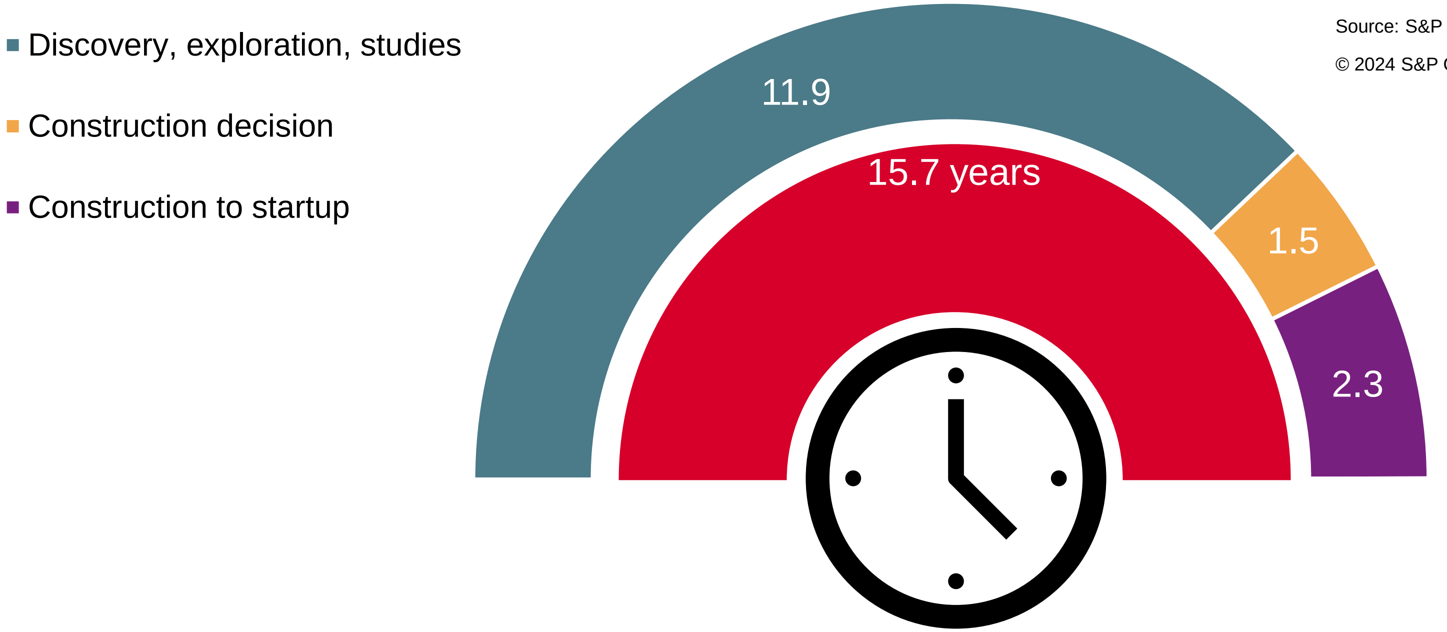
An often-quoted analysis of development times was produced by S&P Global in 2023.[1] That analysis showed that across 127 mines that have come online since 2002 for which S&P Global has consistent, structured data, development times from discovery to production are on average 15.7 years. Almost 12 years of this is typically spent in the stages of discovery, exploration, and the various studies required. A subsequent article considered a much smaller sample of mines that began operating in 2020-2023. Development times for these were even longer, at 17.9 years on average.[2]

Average lead times of mines for discovery to production: 2002-2023

Data compiled April 4, 2023.

* 127 mines in the study including gold, copper, nickel, silver and zinc mines.

Source: S&P Global Market Intelligence.



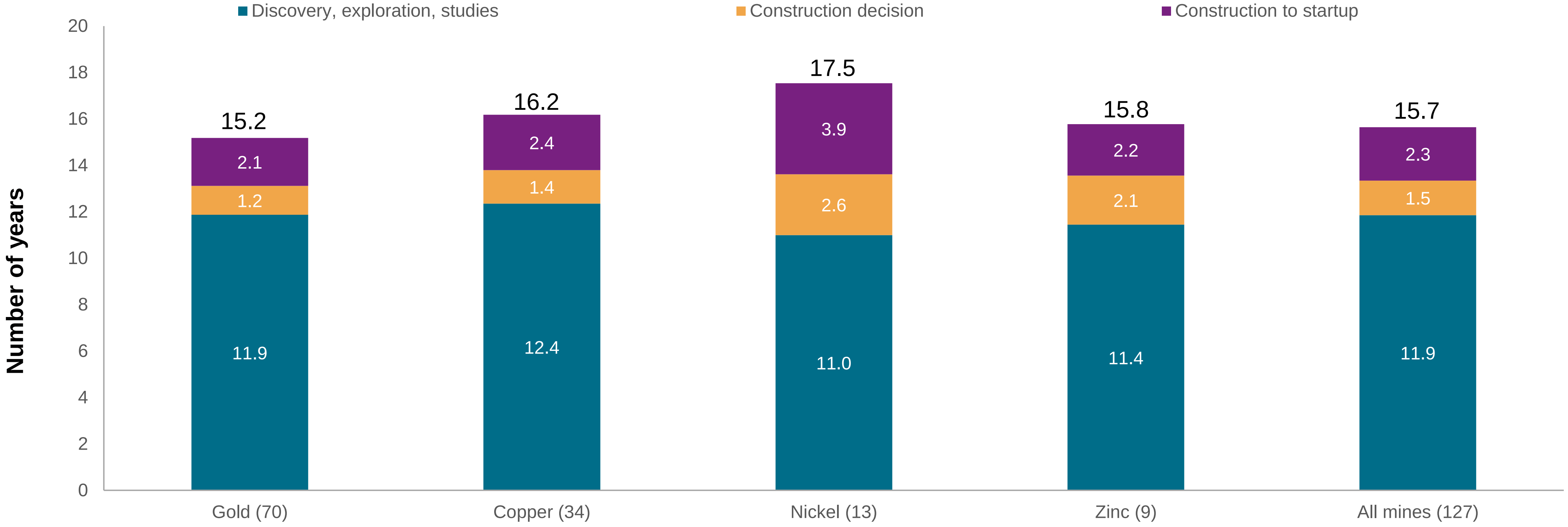
[1] Discovery to Production Averages 15.7 years for 127 mines; Manalo, P, 2023. Link here, accessed 25 April 2024.

[2] Average lead time almost 18 years for mines started in 2020–23; Manalo, P, 2024. Link here, accessed 25 April 2024.

Development times: Lead times by metal around the world

Gold mines accounted for over half of the 127 mines in that analysis. Gold mines go online the fastest, at an average of 15 years. Nickel mines take the longest overall, at nearly 18 years. But the discovery, exploration, studies phases are typically longest for copper, usually accounting for 12 of the 16 years it takes to bring one of these mines online.

Average lead time by metal type



Data compiled April 4, 2023.

Number in parentheses are the number of mines.

Source: S&P Global Market Intelligence.

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Development times: US data are misleading…

Geography	Number of mines included in initial analysis
Australia	11
Canada	11
Peru	9
Burkina Faso	9
Chile	8
Russia	7
Mexico	6
Indonesia	5
China	5
DRC	5
United States	3

At first glance based on that analysis, the US appears to enjoy shorter average lead times than Australia and Canada: 13 years compared with 15 years in Australia, 16 years in Canada, and a global average of also 16 years.

But this is because the analysis cited above considers only the 127 mines that have come online since 2002.

In the US, mines that have come online are exceptions:

- Only three US mines are included in the analysis: Eagle (which came online in 2014), Ruby Hill (2007), and Pogo (2006). Notably, none of these are on federal lands, which impacts the complexity of the permitting process.
- The Eagle mine had an unusually short development time because it was granted a permit by the state of Michigan one year after feasibility was completed, under Part 632, which governs the regulation and permitting of surface and underground nonferrous metal mines in Michigan.
- But the Eagle experience is not typical in the US. While the permitting process is extended, litigation is a major factor keeping mines from starting construction.

Development times: US projects not yet producing

Indeed, several notable properties in the US began the development applications decades ago but have not yet entered production.

Select mining developments in the US

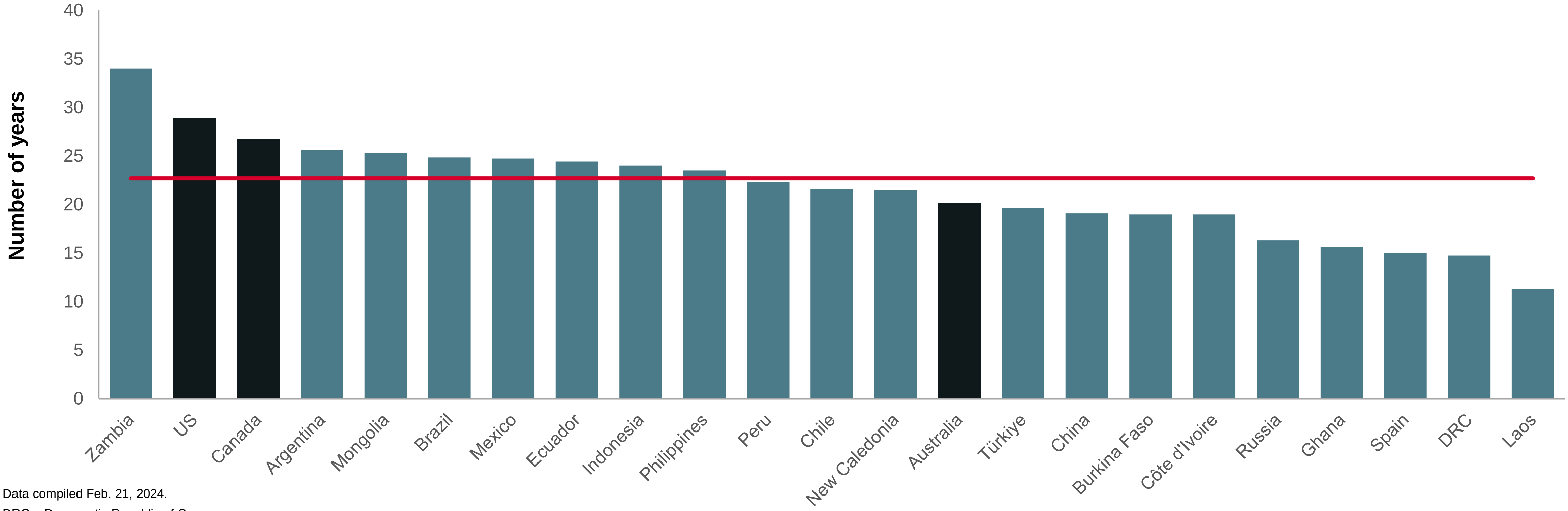
Project name	State	Discovery year	Projected startup	Discovery to now
Copperwood	Michigan	2008	2026	16
Maturi	Minnesota	2006	N/A	18
Resolution	Arizona	1995	N/A	29
Pebble	Alaska	1990	N/A	34
Lithium Nevada	Nevada	1978	2026	46

Development times: Including non-operating mines

In this analysis, we include these non-operating mines. Accordingly, our sample is expanded from 127 mines to 268, including 13 mines in the US, 29 in Canada, and 30 in Australia.

The calculations below use the Projected Startup Year on Capital IQ. Where startup dates are not available, we optimistically assume a startup date of 2030 (thereby treating all mines in all countries the same). **On this basis, the US has the second longest average development times in the world.**

Zambia, the US, and Canada have the longest lead times once we include mines not yet in operation



Data compiled Feb. 21, 2024.

DRC = Democratic Republic of Congo.

* Includes countries with at least two mines.

Source: S&P Global Market Intelligence.

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Development times: In-situ values in the US, Canada, and Australia

Including non-operating mines adds 10 more properties in the US, 18 in Australia, and 19 in Canada. Properties in the US, however, are much larger, with an average in-situ value of more than US$100 billion – over twice that of the additional Canadian properties and nearing five times the additional Australian properties.

This underscores US opportunity. US projects stuck in development are large and may be complex. But exploiting the resources of a relatively small number of projects could release significantly more economic resources in the US than in its peers and help the US domestically source much of the raw material it needs for its energy transition.

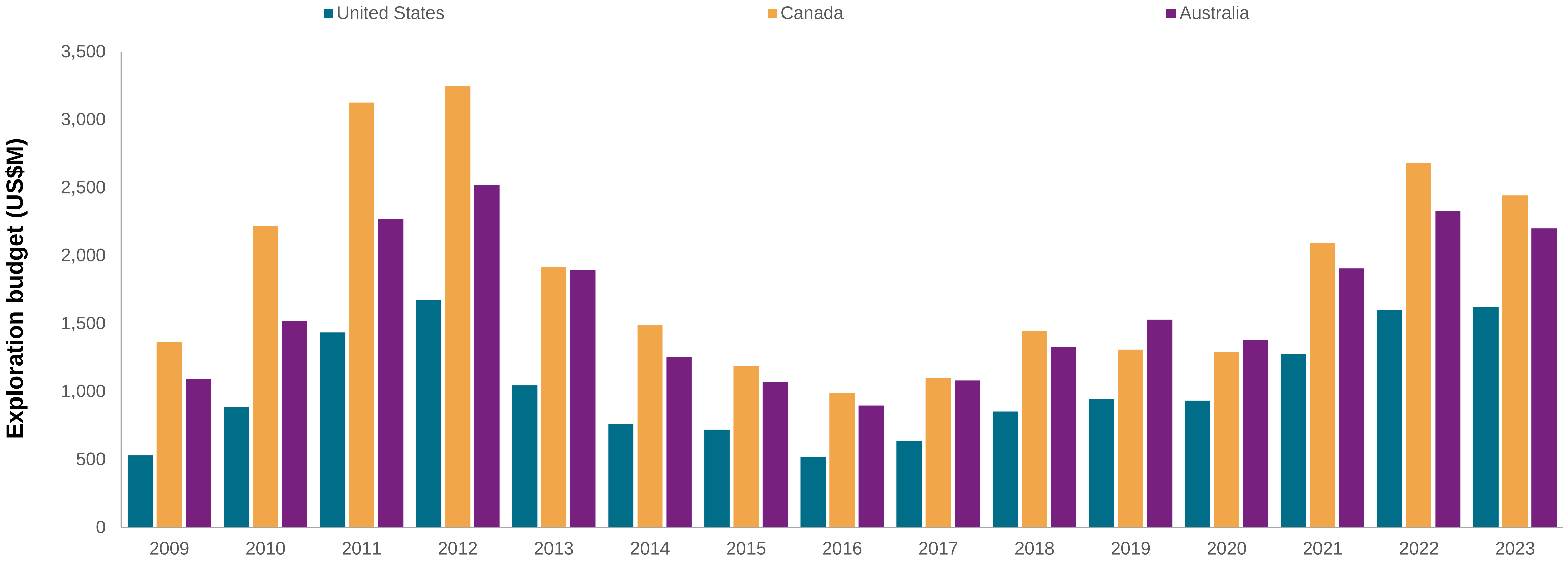
	Operating mines that came online 2002-2023			Non-operating mines (still in development, pre-production)			Total mines (operating and non-operating)		
	No. of properties	In-situ value (US$)	Average value (US$)	No. of properties	In-situ value (US$)	Average value (US$)	No. of properties	In-situ value (US$)	Average value (US$)
Australia	11	367.7 B	33.4 B	18	398.7 B	22.2 B	29	766.5 B	26.4
Canada	11	161.1 B	14.7 B	19	916.5 B	48.2 B	30	1,077 B	35.9
US	3	35.5 B	11.8 B	10	1,039 B	103.9 B	13	1,074 B	82.6

Exploration budgets vs. endowments

Exploration and endowments: Lower investment in the US

Chronically lower mine exploration budgets in the US compound the sense of lost opportunity. Over the last 15 years, mine exploration budgets have been 81% higher in Canada and 57% higher in Australia than in the US.

Comparison of mine exploration budgets by country: 2009-2023



Data compiled Feb. 1, 2024.

Source: S&P Global Market Intelligence.

Exploration and endowments: Endowments as context (1)

Underinvestment occurs despite the US's large mineral endowment as measured by estimated reserves and resources – most of which have not entered production. Indeed, the US has more than twice the lithium reserves and resources of Australia – which accounts for over 50% of global production. The in-situ value, or value of resources and reserves based on current prices, of the US mineral base is on a par with that of Australia and Canada.

Reserves and resources for selected minerals in Australia, Canada, and the US

Mineral	Australia	Canada	US
Copper (metric tons)	143,275,015	103,512,948	275,122,944
Gold (ounces)	561,890,950	829,120,150	541,432,849
Lead (metric tons)	49,233,497	10,206,265	15,649,248
Lithium (metric tons)	19,866,103	28,340,546	43,625,822
Molybdenum (metric tons)	1,629,760	3,959,380	11,353,982
Nickel (metric tons)	36,202,119	41,894,280	3,962,726
Palladium (ounces)	19,486,412	45,802,542	42,392,500
Silver (ounces)	4,154,781,075	4,337,197,837	6,139,536,627
Zinc (metric tons)	99,372,424	42,771,374	30,574,787
In-situ value of reserves and resources (U$ trillion)	9.168	8.196	8.265

Data compiled Feb. 20, 2024.
Notes: In-situ value excludes bulk commodities such as coal, iron ore, and potash, and is defined as the combined value of commodities in reserves and resources at S&P Global Market Intelligence nominal prices for the current year.
Source: S&P Global Market Intelligence.

Exploration and endowments: Endowments as context (2)

Dividing mining exploration budgets by reserves and resources, the US seems to underachieve in exploration budgets relative to Australia and Canada for all minerals listed below except for silver and lead & zinc (which are typically co-mined so exploration budgets are not split out). This includes several key energy transition minerals: copper, lithium, nickel, and palladium.

Mine exploration budget per unit of reserves & resources for Australia, Canada, and the United States (all data US$)

Mineral	Australia	Canada	United States
Copper ($/metric ton)	$1.92	$1.52	$0.98
Gold ($/ounce)	$1.37	$1.24	$1.03
Lead and Zinc ($/metric ton)	$0.46	$0.81	$0.77
Lithium ($/metric ton)	$1.55	$1.02	$0.72
Molybdenum ($/metric ton)	$5.72	$2.04	$0.54
Nickel ($/metric ton)	$4.05	$3.05	$1.54
Palladium ($/ounce)	$0.31	$0.64	$0.13
Silver ($/thousand ounces)	$5.96	$9.10	$6.81

Data compiled Feb 20. 2024.
Notes: Mine exploration budgets for lead and zinc are reported together, so reserves and resources for both metals are added together in this calculation.
Source: S&P Global Market Intelligence.

Policy and uncertainty

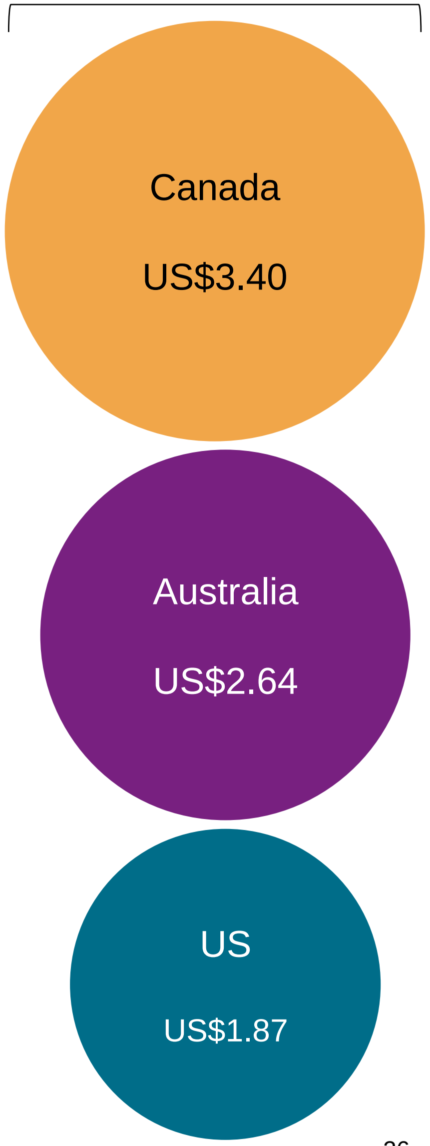
Policy and uncertainty: US and its peers

This striking difference in exploration budgets is likely in large part to the uncertainty around US development times. While in Canada detailed environmental impact studies and engagement with affected stakeholders may take as much time as in the US, in the US there is less certainty around finally reaching production. In addition to this, there is generally higher litigation risk in the US, both before and after production is permitted.[1]

There is widespread recognition across the US political spectrum that permitting has become a huge stumbling block for the development of its mineral resources. Challenges vary depending on the jurisdiction. On private or state lands, permitting is generally more predictable, with a relatively clear path for approval. On federal lands, permitting is characterized by delays, unpredictability and increasing costs. This is a major constraint because federal lands comprise almost half of the total terrain of the 11 mineral-rich western states – and over 60% of Alaska. Moreover, the up-front costs for hard rock mining are much greater than for other kinds of energy projects.

These challenges exist to varying degrees in Canada and Australia too. Federal and state/provincial authorities can have overlapping jurisdictions and several agencies are involved in the final authorization of a mining project. But those countries – in which primary mining accounts for a much more significant part of GDP – have dedicated ministerial offices to oversee mining and the development of national mineral resources in the public interest. No comparable office exists in the US.

Exploration budget per US$1,000 of estimated endowment [3]



[1] S&P Global's metals and mining database contains 32 mentions of litigation against US properties, more than those for Australia (19) and Canada (2) combined. These mentions, however, are not from a structured field and are not reliable by themselves.

[2] The Us Bureau of Mines was established in the Department of Interior in 1910. In 1996, however, it was dissolved.

[3] Total exploration budgets, 2009-2023, per US$1,000 in-situ value of reserves and resources, all minerals, all mines.

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