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Supplementary document to the report
"Beyond Extraction: Pathways for a 1.5°C-aligned Energy Transition with Less Minerals"

Minerals Mapping Approach and Integration with a Global Restricted Areas Map

Greenpeace International, March 2026

Summary

In the context of the study, *Beyond Extraction: Pathways for a 1.5°C-aligned Energy Transition with Less Minerals*, this document outlines the approach to approximating the location of global mineral[1] reserves in relation to areas that should be off-limits to mining. Different types of Restricted Areas were identified to support the aforementioned study and the connected Global Restricted Areas map. This analysis, however, specifically focuses on Restricted Areas 1 (RA1): areas that should be off-limits to mining.

Focusing on nickel, lithium, and cobalt, the spatial analysis method overlays publicly available mineral occurrence, mining, and permitting data to approximate "Reserve Proxy Areas" (RPAs). Although this approach cannot precisely delineate reserves areas, it provides a scalable framework to identify development pressures that may emerge. The resulting spatial layer of RPA is thus summarised as "Potential Development Areas" in the public map.

The methodology emphasises countries accounting for over 80% of global reserves, with a focus on Argentina, Australia, Brazil, Canada, Chile, China, the Democratic Republic of the Congo, Indonesia, New Caledonia, the Philippines, and the United States. Verification was carried out through country-level checks and case studies, which highlighted certain data gaps, particularly in fast-changing mining regions such as Indonesia. Results show significant overlap between potential reserves areas and RA1: approximately 45% of nickel, 57% of lithium, and 27% of cobalt reserves globally may be located in Restricted Areas that should be off-limits to mining. This has implications for potential mineral supplies.

The findings should be seen as directional rather than definitive, serving as a high-level screening tool relevant for global analysis only. The methodology has known limitations, including incomplete datasets, varying resolution across countries, and reliance on assumptions such as uniform distribution of reserves across RPAs. Importantly, RPAs are intentionally described as a proxy – the method cannot precisely define reserve locations. Nevertheless, by identifying both risks and opportunities, this mapping initiative can support the protection of critical areas, while highlighting the importance of shifting toward solutions that reduce reliance on newly mined minerals.

[1] The term "mineral" is used here as an umbrella term that includes "metal" or "element" in this context referring to lithium, nickel, cobalt and others. Given the prevalence of terms like "critical mineral" and "energy transition mineral" in the current discourse, "mineral" is the most straightforward term in this context.

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1. Introduction

Many projections outline significant growth in demand for transition minerals in the coming decades. These projections are then used to justify expansion of mining, sometimes in ecologically sensitive or culturally significant areas that should be off-limits to extractive industries.

The Institute of Sustainable Futures' study, *Beyond Extraction: Pathways for a 1.5°C-aligned Energy Transition with Less Minerals*, addresses this challenge through two complementary approaches:

1. Evaluating the potential of alternatives, including less mineral-intensive technologies, transport policies, and circular economy strategies that reduce overall mineral demand from mining; and
2. Assessing the potential reserves of energy transition minerals in relation to Restricted Areas that should be off-limits to mining (RA1), which is the subject of this document.

To understand the proportion of minerals in RA1, the study analyses the geographic distribution of areas likely to be associated with reserves in key mineral-producing countries and overlays this data with the global Restricted Areas map[2]. This spatial analysis is essential, as significant portions of the world's mineral reserves may be inaccessible, not due to technical or economic constraints, but because they are located in areas that should remain protected.

2. Global Restricted Areas Mapping

The global Restricted Area mapping approach compiled spatial datasets from authoritative, publicly accessible sources that were screened for data quality, reliability, and resolution. Based on this, it identified critical areas that should be off-limits to extractive activities (RA1). This includes areas considered off-limits by default, such as Protected Areas, Intact Forest Landscapes, and areas with high natural values exceeding a threshold in criteria including significant natural ecosystems, critical water bodies, high conservation value, and high carbon stock areas. The approach also highlights additional areas of high natural values that in particular require further assessment (also referred to as 'RA2'). Moreover, the Free, Prior, and Informed Consent (FPIC) of Indigenous Peoples and Local Communities is considered a prerequisite of any development globally and is thereby understood as a global primary type of restriction called RA-FPIC.

3. Mineral Mapping Data

In 2025, Greenpeace identified 8 minerals as most important to its network in the context of energy transition, clean energy technologies, and infrastructure. These are copper, cobalt,

[2] The Restricted Areas web map, and additional related information, can be found at this link: https://maps.greenpeace.org/maps/gpint/restricted-areas/

manganese, lithium, nickel, graphite, neodymium and dysprosium – the last two being Rare Earth Elements (REE).

This mapping effort specifically focuses on three key minerals: lithium, nickel, and cobalt. These are used intensively in energy transition technologies (such as batteries for electric vehicles and stationary storage). Early scenario analysis in the study suggested that potential demand for these minerals could represent a substantial share of global reserves, so they were prioritised for mapping.

To identify reserve areas for these three minerals, several types of data were collected: 1) mineral point data from various sources suggesting the presence of that mineral at various stages of development (ranging from occurrences to exploration, mining, and post-closure); 2) mineral permit data, which can serve as a useful proxy for identifying potential areas of mineral reserves, particularly when metadata can be filtered by the specific commodity of interest; and 3) mapped areas of mining globally. Data was not independently verified. It was collected from a range of global and region-specific sources that are summarised in Section 6, including:

1. **Local Government Data Sets (national, regional, provincial, or territorial)**. These datasets typically include 1) commodity-specific, geospatially referenced data on mineral-related occurrences within national or territorial borders; and 2) mining permit or concession data (also called tenements), a subset of which contains searchable metadata on the target minerals of interest.

2. **Global Government Data Sets**
   a. **Global or Region-Specific Geospatial Datasets**. Data from the Government of Canada and the U.S. Geological Survey (USGS) contains geospatially referenced information on mineral-related occurrences and infrastructure across many countries and regions.
   b. **Mineral Commodity Summaries**. The U.S. Geological Survey (USGS) provides a comprehensive dataset on country-level mineral reserves through its annual Mineral Commodity Summaries and Minerals Yearbook. This dataset includes estimates of the quantity and distribution of mineral reserves, including nickel, cobalt, copper, lithium, rare earth elements, and others across various countries. This data does not include spatial analysis of where reserves are located within countries.

3. **Academic Publications & Related Supplemental Data.** These datasets typically contain global lists of geospatially referenced data on mineral-related occurrences or mining activities. The data may be specific to certain minerals of interest or may relate to non-mineral-specific mining activities.

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4. Methods

4.1 Areas of Focus

For each mineral, countries were compiled and ranked by their reported reserve volumes and calculated cumulative totals to determine the smallest set of countries accounting for the majority of global supply. This enabled researchers to focus analysis on a targeted group of high-reserve countries (those collectively holding over 80% of known global reserves) for further spatial evaluation (Table 1).

Countries with significant reserves of nickel, cobalt, and lithium were prioritised, as initial scenario analysis results in the study suggested that the demand for these minerals could represent a substantial share of global reserves. Thirteen countries emerged as high-priority due to their critical roles in supplying these: **Argentina, Australia, Brazil, Canada, Chile, Cuba, Indonesia, China, the Democratic Republic of the Congo (Kinshasa), New Caledonia, the Philippines, Russia, and the United States**. Due to data availability issues, Russia and Cuba were removed from the analysis.

Case study countries included Indonesia and Sweden, based on Greenpeace Network interest and relevance.

Table 1: Priority Countries by Reserves Ranking for Key Minerals (U.S. Geological Survey, 2025)

Reserves Ranking based on U.S. Geological Survey (2025)	**Lithium**	**Nickel**	**Cobalt**
1	Chile	Indonesia	Congo (Kinshasa)
2	Australia	Australia	Australia
3	Argentina	Brazil	Indonesia
4	China	Russia (excl.)	Cuba (excl.)
5	United States	New Caledonia	Philippines
6	Canada	Philippines	Russia (excl.)
% of world*	**88%**	**81%**	**80%**

**The percentages reported here do not include the countries noted with "(excl.)". They are listed in the table because they are among the top reserves in the world.*

4.2 Approximating Reserve Locations

Identifying the precise location and quantity of mineral reserves at a global scale would be very complex and resource-intensive. Accurate delineation requires detailed and often proprietary geological data, detailed subsurface mapping and modelling, and expert interpretations; such information is not consistently publicly available across all countries and minerals.

Given these limitations, this study adopts a spatial approximation approach using publicly available Geographic Information System (GIS) data to estimate the likely location and extent of current and future reserves. **While not intended to define exact reserve boundaries or volumes**, this method offers a scalable framework for spatially derived reserve estimation that supports comparative analysis globally. For clarity, this process is aimed at estimating reserve locations and not resource locations (US Geological Survey, 2025).

The methodology consists of the following sequential steps:

4.2.1 Data Compilation

Spatial datasets were collected and standardised, including:

1. Mineral point data representing mineral occurrences or deposits for lithium, nickel, and cobalt (global and regional data sets),
2. Mining polygons delineating the footprint of active or historical mines, and
3. Mineral permit (also called tenement or concession) polygons indicating areas authorised for exploration or development (regional data from governments).

4.2.2 Buffer Application

To account for positional inaccuracies and spatial uncertainty, a uniform 5-kilometre buffer was applied to the commodity point data, and a 1-kilometre buffer was applied to the mining polygons. Buffers increase the likelihood of capturing relevant spatial relationships while accounting for data uncertainty and potential reserve expansion or development that is not reflected in the datasets.

4.2.3 Identification of Reserve Proxy Areas (Potential Development Areas)

Intersections between spatial datasets were used to infer potential mineral reserve locations, or areas in which mineral development may occur. The approach is based on the premise that certain types of co-located data increase the likelihood of reserves being delineated in a particular location. For example, if a known mineral occurrence (mineral point data) is located within or near a mining polygon (representing active or historic mining activity), it is reasonable to infer that the mine could be extracting that commodity and that reserves may have been delineated in this location. Similarly, if permits have been granted for exploration or development for a specific commodity in an area with active mining, this strengthens the inference of reserve presence.

In the case of cobalt, which is often produced as a co-product of other mineral production (Dehaine et al., 2021), in data-poor areas it was assumed that cobalt reserves areas would be associated with a primary commodity. For example, cobalt RPAs in Indonesia and the Philippines are associated with nickel RPAs, but sufficient data was available in Australia and the DRC for independent analysis.

While not definitive, this approach can provide useful proxies for identifying areas with potential reserves and therefore development pressure across different geographies and commodities. On the Restricted Areas map, Reserves Proxy Areas are called "Potential Development Areas".

Reserve proxy areas are identified through:

1. Intersections between buffered mining polygons and buffered commodity point data; and
2. Intersections between buffered mining polygons and permit data filtered by commodity

In both cases, the intersecting buffered mining polygon is classified as a "Reserves Proxy Area". These intersections suggest a higher likelihood of reserves because they align known mineral occurrences and/or permitting information with satellite-visible mining activity.

Such areas are often concentrated near sites of existing or historical development; however, not all global reserves are located near active mining regions. Reserve Proxy Areas should be regarded as a screening tool. They are useful for identifying potential reserve areas and development pressures, but they should not be interpreted as definitive reserve boundaries.

4.2.4 Spatial Allocation of Reserves

The amount of reserves reported in the USGS Commodity summaries are allocated evenly across the selected mining polygon areas. It is important to note that this approach does not capture the inherent complexity of mineral deposit variability and the associated definition of reserves, such as differences in ore body geometry, depth, grade, or other aspects of ore quality. These factors significantly influence how and where mineral reserves are delineated but are not consistently available across global datasets.

As a result, it is assumed for the purpose of this global analysis that reserves are uniformly distributed over the total area of the identified polygons. This simplification does not reflect the true heterogeneity of mineral deposits and reserves delineation, as there was no feasible way to account for these variables at the scale and scope of this study.

Furthermore, as not all reserves in all countries were analysed (just those representing 80% or more of reserves for each mineral), it is also assumed that the total share of Reserves Proxy Areas within RA1 also applies to the other countries that were not evaluated. For example, of the countries analysed for nickel (which represent 81% of global reserves), approximately 45% of Reserves Proxy Areas were located in RA1. We assume, for the purposes of this global analysis, that 45% of the Reserves Proxy Areas for the remaining 19% of reserves would also be located in RA1.

Such approximations are suitable for high-level spatial analysis and global scenario analysis risk identification in the context of global mineral demands. Finer-scale or site-specific assessments of reserves locations will require more detailed geological and operational data and relevant expert analysis.

4.2.5 Testing, Verification, and Quality Control

Testing
To assess the reliability of the reserve mapping methodology, case studies were carried out in Sweden (copper) and Indonesia (nickel), two major mineral-producing countries in distinct geographies. These case studies evaluated whether data intersections reflected known mining activity and reserve areas, while also testing different approaches for defining Reserves Proxy Areas. The objective was to achieve a balance: capturing most of the relevant mining areas without excessive over-selection or omission.

In Indonesia, the recent rapid expansion of nickel mining created significant data gaps. The dataset from Maus et al. (2022) did not capture many of the newer mining polygons in the region, which prompted the integration of Planet Mosaic data into the methodology. By contrast, the copper mining analysis in Sweden was found to be generally accurate, with fewer discrepancies.

Verification and Quality Control
Reserves Proxy Areas in each country underwent a manual quality control process by commodity. The process began with a spot check for false positives and false negatives to confirm whether well-known mines were accurately selected and whether any mines appeared to be incorrectly excluded or included. Accuracy was assessed using a combination of study data layers, Google Maps, and additional desktop research. Where the spot check revealed minimal errors, the analysis was considered adequate.

In countries where multiple errors were identified, each Reserves Proxy Area polygon was manually reviewed for accuracy. False positives were most common in data-rich regions, particularly where publicly available sampling data was abundant. For example, in Australia many inactive mines were selected as RPAs, presumably due to abundant sampling programme data of historic mines. Sites were assessed as abandoned or inactive if imagery showed overgrown vegetation and the absence of vehicles or trailers or infrastructure in Google Maps. False positives were also common in areas where permitting data listed many commodities as potential targets, rather than the primary commodities of interest. False negatives were less common, but when identified, they were incorporated as Reserves Proxy Areas using publicly available information from corporate and/or government sources.

Refineries were excluded from the analysis where possible, as the focus remained on geological reserves rather than processing infrastructure.

To define missing activity in known high-priority mining zones, such as recent nickel mining activity in Indonesia, additional verification was carried out for known reserve areas using Planet Mosaic satellite imagery. This imagery was used to detect recent land use changes, such as vegetation clearance or site infrastructure associated with new or expanding mining operations. Cross-checking strengthened the reliability of the analysis, particularly for regions undergoing rapid development. However, the results of the methodology remain a high-level approximation tool, best suited for global screening rather than precise reserve delineation.

4.3 Comparison of Reserves Proxy Areas with Restricted Areas

The Reserves Proxy Areas were systematically compared against the Restricted Areas mapping at the country level to evaluate potential constraints on mineral availability. This comparison identified the proportion of Reserve Proxy Areas that are situated within and outside Restricted Areas 1 (RA1), offering an initial estimate of the spatial overlap between potential mineral development areas and areas that should remain off-limits to mineral extraction.

This analysis includes the following steps:

1) *Overlay of Reserve Proxy Areas with the Restricted Areas map*: Intersect the two datasets to identify where estimated reserves coincide with RA1 boundaries.
2) *Quantification of Reserves Proxy Areas inside and outside Restricted Areas 1*: Calculate the area and proportion of Reserves Proxy Areas polygons falling within RA1. Express results both as absolute areas and as percentages of total identified reserves.
3) *Area-based estimate of minerals*: Derive an estimate of the reserves outside Restricted Areas 1, assuming reserves are equally distributed across Reserve Proxy Areas. Express results as a share of total reserves.

4.3.1 Interpretation and Implications

When substantial shares of Reserve Proxy Areas are located within Restricted Areas (RA1, or others), this signals a constraint on future mineral development locations. In such cases, the RA1 areas can be considered as off-limits to mining. In all other areas, extraction of minerals is subject to further detailed expert assessments and local consultation to gather higher resolution and quality data and is still subject to strict environmental, social, and governance safeguards, and in particular FPIC from Indigenous Peoples and Local Communities.

This comparison should be treated as a screening-level assessment tool. It is intended to provide directional insights with indicative information on what areas should be off-limits and the indicative potential global mineral availability under critical environmental and development constraints, rather than definitive boundaries at an operational level of where mining may or may not occur.

4.3.2 Limitations

While the method provides a consistent and scalable proxy for identifying reserve locations, it has limitations. For example, more recent or smaller-scale mining operations may not yet appear in the available datasets, particularly in regions where permit data is incomplete or outdated. This can result in under-representation of newly developed areas, which was a particular challenge in Indonesia. There are also presumed errors in the point data when it plots in unlikely locations, and in some cases limited information where minerals are produced as co-products of other commodities (e.g., cobalt). Mineral point data was not independently verified.

In some regions, permit data is incomplete or lacks sufficient detail, particularly the ability to filter by specific commodity. This limits the precision of identifying potential reserves based on permit intersections. In the absence of permit data, the analysis must rely more heavily on intersections between mineral point data and mining polygons. This approach still provides a useful proxy, but it is likely to identify less Reserve Proxy Areas.

Recognising that proxy reserves and Restricted Areas are derived from heterogeneous datasets with varying resolution, there is inherent spatial uncertainty in the analysis, with Restricted Areas datasets converted into uniform layers with a spatial resolution at approximately 300m resolution and Reserves Proxy Areas at approximately 30m resolution.

Ultimately, the Reserve Proxy Areas identified through this method should be interpreted as indicative rather than definitive. This can provide a valuable first step in highlighting areas of potential overlap between mineral development and essential environmental protection and respect for IP&LC rights, but they require further validation through local datasets, ground-truthing, and consultation with Indigenous Peoples, local communities, and regional experts to ensure accuracy and applicability in decision-making.

It is important to note that this mapping gives an indication of the fraction of estimated reserve area that is in Restricted Areas 1 (RA1). The fraction of mineral quantity that is within or outside RA1 has been estimated on the basis of area, not geological characteristics such as orebody geometry or ore grades. Furthermore, RPAs are intentionally described as a proxy – the method cannot precisely define reserves locations.

5. Results and Discussion

Preliminary results show substantial overlap between potential mineral reserves and Restricted Areas that should be off-limits to mining (RA1): approximately 45% of global nickel, 58% of lithium, and 27% of cobalt reserve areas may lie within such areas. Details are outlined in Tables 2, 3, and 4.

These findings serve as a directional, high-level screening tool to inform strategic planning and policy discussions. Known limitations include incomplete datasets, variable spatial resolution, and the assumption of uniform reserve distribution across RPAs.

Despite these uncertainties, the combined methodology provides an important foundation for understanding potential conflict between the extraction of minerals for the global energy transition and biodiversity, natural ecosystem values and nature protection, as well as IP&LC's rights, highlighting the urgent need to reduce mineral demand and prioritise sustainable alternatives, as shown in the scenario analysis results in the *Beyond Extraction: Pathways for a 1.5°C-aligned Energy Transition with Less Minerals* report.

As noted, the analysis of local and regional contexts necessitates a more detailed examination of the available data, as the current findings are only applicable in aggregate, at the global level. For illustrative purposes, the mapping in Indonesia, one of the case study areas, is shown in Figure 1. In this region, approximately 58% of nickel and cobalt Reserves Proxy Areas are located in Restricted Areas 1 (RA1). Reserve Proxy Areas located outside of RA1 will also be subject to the Free, Prior, and Informed Consent (FPIC) of Indigenous Peoples and Local Communities.

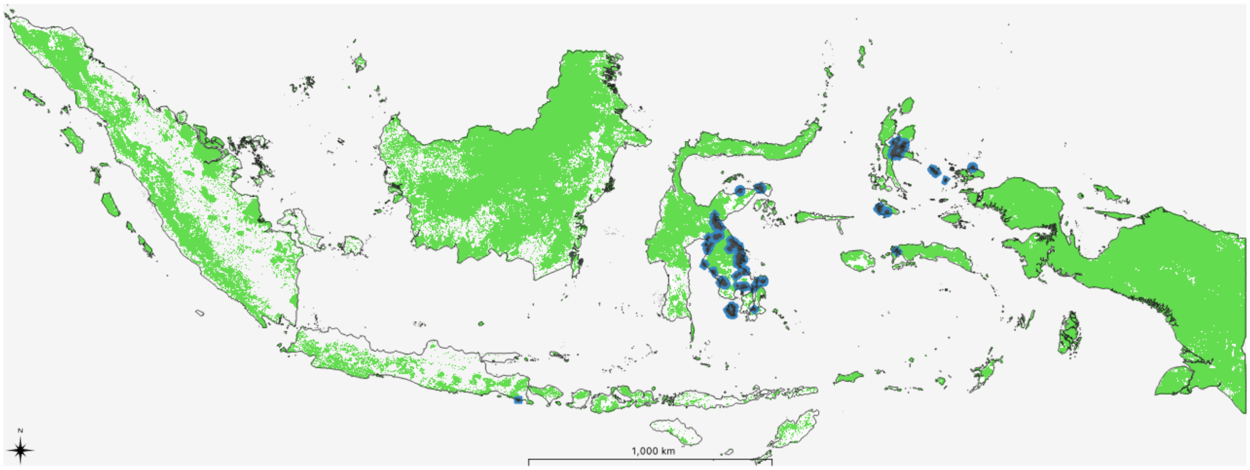

Figure 1: Example of mapping results in Indonesia showing Restricted Areas 1 "RA1" (*green* = off-limits to mining, including by Default and by Values) and Reserve Proxy Areas (*blue* = cobalt, *grey* = nickel)

Table 2: Analysis of Nickel Reserves Proxy Areas located in Restricted Areas that should be off-limits to mining ("RA1")

Country	**Nickel Reserves Proxy Area (RPA), Total (ha)**	**Portion of Nickel RPA located in "RA1" (ha)**	**Portion of Nickel RPA located in "RA1" (%)**	**Nickel Reserves (Tonnes) USGS, 2025**	**Estimated Nickel Reserves (by area) outside "RA1 (Tonnes)**
Indonesia	280,975	163,520	58%	55,000,000	22,991,405
Australia	179,045	32,361	18%	24,000,000	19,662,130
Brazil	49,589	13,555	27%	16,000,000	11,626,644
New Caledonia	119,320	68,956	58%	7,100,000	2,996,845
Philippines	80,987	54,134	66%	4,800,000	1,591,546
Total				**106,900,000**	**58,868,571**
			Total Global Reserves	131,000,000	*rounded*
			Portion of Total Global Reserves Represented (%)	81%	
			Estimated Portion of Global Reserves Area inside RA1 (%)		45%
			Estimated Portion of Global Reserves Area outside RA1 (%)		55%
			Estimated Reserves, by area, outside RA1 (Tonnes)		72,140,157
			Estimated transition demand, Progressive Accelerated Na-ion Scenario (Tonnes)		33,630,758
			Transition demand as a portion of estimated reserves outside RA1 (%)		47%

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Table 3: Analysis of Lithium Reserves Proxy Areas located in Restricted Areas that should be off-limits to mining ("RA1")

Country	Lithium Reserves Proxy Area (RPA), Total (ha)	Portion of Lithium RPA located in "RA1" (ha)	Portion of Lithium RPA located in "RA1" (%)	Lithium Reserves (Tonnes) USGS, 2025	Estimate of Lithium Reserves (by area) outside "RA1" (Tonnes)
Australia	38,270	7,495	20%	7,000,000	5,629,086
USA	163,914	38,278	23%	1,800,000	1,379,660
Chile	180,744	161,600	89%	9,300,000	985,032
Argentina	230,040	202,498	88%	4,000,000	478,903
China	709,798	286,325	40%	3,000,000	1,890,000
Canada	26,718	5,283	20%	1,200,000	962,715
Total				**26,300,000**	**11,325,396**
Total Global Reserves				30,000,000	*rounded*
Portion of Total Global Reserves Represented (%)				88%	
Estimated Portion of Global Reserves Area inside RA1 (%)					57%
Estimated Portion of Global Reserves Area outside RA1 (%)					43%
Estimated Reserves, by area, outside RA1 (Tonnes)					12,918,702
Estimated transition demand, Progressive Accelerated Na-ion Scenario (Tonnes)					10,461,881
Transition demand as a portion of estimated reserves outside RA1 (%)					81%

Table 4: Analysis of Cobalt Reserves Proxy Areas located in Restricted Areas that should be off-limits to mining ("RA1")

Country	Cobalt Reserves Proxy Area (RPA), Total (ha)	Portion of Cobalt RPA located in "RA1" (ha)	Portion of Cobalt RPA located in "RA1" (%)	Cobalt Reserves (Tonnes) USGS, 2025	Estimate of Cobalt Reserves (by area) outside "RA1" (Tonnes)
Indonesia	265,780	157,208	58%	640,000	265,974
Australia	180,819	30,717	17%	1,700,000	1,411,208
DRC*	249,694	60,772	24%	6,000,000	4,539,695
Philippines	73,872	48,514	66%	260,000	89,248
Total				**8,600,000**	**6,301,593**
Total Global Reserves				11,000,000	*rounded*
Portion of Total Global Reserves Represented (%)				80%	
Estimated Portion of Global Reserves Area inside RA1 (%)					27%
Estimated Portion of Global Reserves Area outside RA1 (%)					73%
Estimated Reserves, by area, outside RA1 (Tonnes)					8,060,515
Estimated transition demand, Progressive Accelerated Na-ion Scenario (Tonnes)					1,906,515
Transition demand as a portion of estimated reserves outside RA1 (%)					24%

*The USGS Commodity Summaries refers to this area as Congo (Kinshasa)

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6. Data Sources and References

Source Data Tables

GLOBAL DATA

Source	Type	Reference	Relevance
Academia	Point Data	Heijlen, W., Franceschi, G., Duhayon, C., and Van Nijen, K., (2021). Assessing the adequacy of the global land-based mine development pipeline in the light of future high-demand scenarios: The case of the battery-metals nickel (Ni) and cobalt (Co). Resources Policy, Volume 73.	Global list of nickel and cobalt mines and projects
Government (Canada)	Point Data	Kirkham, R. V., and Rafer, A. B. (2003). Selected world mineral deposits database, Government of Canada.	Global list of selected mineral deposits
Academia	Point Data	Labay, K., Burger, M.H., Bellora, J.D., Schulz, K.J., DeYoung, J.H., Jr., Seal, R.R., II, Bradley, D.C., Mauk, J.L., and San Juan, C.A., (2017). Global Distribution of Selected Mines, Deposits, and Districts of Critical Minerals	Global Distribution of Selected Mines, Deposits, and Districts of Critical Minerals
Academia	Polygon Data	Maus et al., 2022 - Version 2**.** Maus, V, da Silva, D., Gutschlhofer, J., da Rosa, R., Giljum, S., Gass, S., Luckeneder, S., Lieber, M., McCallum, I (2022). Global-scale mining polygons (Version 2) [dataset]. PANGAEA.	Global-scale Mining Polygons
Academia	Point Data	Mervine, E., Valenta, R., Paterson, J., et al., (2025). Biomass carbon emissions from nickel mining have significant implications for climate action. Nat Commun, 16, 481.	Global list of nickel mines
Academia	Point Data	Northey, S., Mudd, G., Werner, T., Jowitt, S., Haque, N., Yellishetty, M., Weng, Z., (2017). The exposure of global base metal resources to water criticality, scarcity and climate change. Global Environmental Change, Volume 44, Pages 109-124	Global list of nickel and copper mines

Source	Type	Reference	Relevance
Academia	Point Data	Owen, J.R., Kemp, D., Lechner, A.M. et al., (2023). Energy transition minerals and their intersection with land-connected peoples. Nat Sustain 6, 203–211.	Global list of transition mineral projects
Government (USA)	Point Data	Schulz, K., and Briskey, J., (eds), (2005). Reviews of the Geology and Nonfuel Mineral Deposits of the World, United States Geological Survey (USGS), *see*: Major mineral deposits of the world	Global list of select mineral deposits
Academia	Point Data	Benson, T. R., Jowitt, S. M.; Simon, A. C., (2025). Special Issues on the Geology and Origin of Lithium Deposits—Introduction: Lithium Deposit Types, Sizes, and Global Distribution	Global list of lithium deposits
Government (USA)	Point Data	Schulz, K. J., DeYoung, J. H., Jr., Seal, R. R., II, & Bradley, D. C., (2017). Critical Mineral Resources of the United States—Economic and Environmental Geology and Prospects for Future Supply (U.S. Geological Survey Professional Paper 1802). U.S. Geological Survey. Supplement: Global Distribution of Selected Mines, Deposits, and Districts of Critical Minerals.	Global Critical Mineral Deposits
Planet Mosaic	Satellite Data	Planet Mosaic Industrial Basemaps. Accessed September 2025.	Satellite Imagery of mining areas

REGIONAL DATA

Source	Type	Reference	Relevance
AFRICA			
Government (USA)	Point Data	Padilla, A. D., Otarod, D., Deloach-Overton, S. W., Kemna, R. F., Freeman, P. A., Wolfe, E. R., Bird, L. R., Gulley, A. L., Trippi, M. H., Dicken, C. L., Hammarstrom, J. M., & Brioche, A. S., 2021. Compilation of Geospatial Data (GIS) for the Mineral Industries and Related Infrastructure of Africa. U.S. Geological Survey data release. https://doi.org/10.5066/P97EQWXP	Mineral deposits in Africa, including DRC
Government (DRC)	Permit Data	DRC Mining Cadastre Map Portal. Accessed August 2025.	Mineral permits of DRC
ASIA			

Source	Type	Reference	Relevance
Government, (USA)	Point Data	Padilla, A. D., Buteyn, S., Neustaedter, E. R., Otarod, D., Wolfe, E. R., Freeman, P. A., Trippi, M. H., Kemna, R. F., Trimmer, L. M., Renaud, K., Szczesniak, P. A., Moon, J. W., Chung, J., Dicken, C. L., & Hammarstrom, J. M. (2022). Compilation of Geospatial Data (GIS) for the Mineral Industries and Related Infrastructure of Select Countries in Southwest Asia. U.S. Geological Survey data release. https://doi.org/10.5066/P9OCRYYO	Mineral deposits in SW Asia, including Indonesia
Government, (USA)	Point Data	Neustaedter, E. R., Buteyn, S., Moon, J. W., Trimmer, L. M., Padilla, A. D., Wolfe, E. R., Fierro, E., Freeman, P. A., Trippi, M. H., Decarlo, K. F., Kemna, R. F., Renaud, K., Agyepong, L. A., Jafari, Z., Otarod, D., Dicken, C. L., & Hammarstrom, J. M. (2023). Compilation of Geospatial Data (GIS) for the Mineral Industries and Related Infrastructure of the People's Republic of China. U.S. Geological Survey data release. https://doi.org/10.5066/P9HK2K8I	Mineral deposits in China
Government, (USA)	Point Data	Trimmer, L. M., Neustaedter, E. R., Chung, J., Decarlo, K. F., Moon, J. W., Fierro, E., Jafari, Z., Agyepong, L. A., Wolfe, E. R., Padilla, A. D., Freeman, P. A., Trippi, M. H., Dicken, C., Hammarstrom, J. M., Paul, J., & Foeppel, J. S. (2024). Compilation of Geospatial Data (GIS) for the Mineral Industries of Select Countries in the Indo-Pacific. U.S. Geological Survey, data release. https://doi.org/10.5066/P13YRCDU	Mineral deposits in 19 countries the Indo-Pacific region, including New Caledonia and the Philippines
Government of New Caledonia	Permit Data	Mining in New Caledonia: mining centers and metallurgical plants. Gouvernement de la Nouvelle-Calédonie / DIMENC / SMC. Accessed August 2025.	Mineral Permits of New Caledonia
Government (Indonesia)	Permit Data	Mineral dan Batubara ESDM Geoportal. Ministry of Energy and Mineral Resources. Accessed July 2025.	Mineral Permits of Indonesia
Government (Philippines)	Permit Data	Mines and Geosciences Bureau. Mining Tenement Control Maps. Accessed September 2025.	Mineral Permits of Philippines
AUSTRALIA			
Government (Australia)	Point Data	Geoscience Australia. (2020). Australia's Identified Mineral Resources, Geoscience Australia's Web Feature Service (WFS), Accessed August 2025.	Mineral deposits in Australia

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Source	Type	Reference	Relevance
Government (Western Australia)	Point Data	Government of Western Australia. Mines and Mineral Deposits (MINEDEX). Accessed August 2025.	Minerals of Western Australia
Government (South Australia)	Point Data, Permit Data	South Australian Resources Information Gateway. Accessed August 2025.	Minerals and Permits of South Australia
Government (Northern Territory, Australia)	Point Data	STRIKE Tenure and Geoscience Information Department of Mining and Energy. Accessed August 2025.	Minerals of Northern Territory
Government (New South Wales, Australia)	Permit Data	MinView Geoscience data for NSW. Accessed August 2025.	Mineral Permits of NSW
Government (Tasmania, Australia)	Permit Data	Mineral Resources Tasmania. Accessed August 2025.	Mineral Permits of Tasmania
Government (Queensland)	Permit Data	Business Queensland. Online services for mining and resources. Accessed August 2025.	Mineral Permits of Queensland
EUROPE			
Government (Sweden)	Point Data	Geological Survey of Sweden, or *Sveriges geologiska undersökning, SGU*. (2025). Swedish Mineral and Bedrock Occurrences; and Ores and Concentrators	Mineral deposits in Sweden
Government (European Union)	Point Data	Albert, C., & Bertrand, G. (2025). Dataset for the Map of Critical Raw Materials hard rock deposits of Europe 2024.	Critical Mineral Deposits in the EU, including Sweden (case study)
NORTH AMERICA			

Source	Type	Reference	Relevance
Government (USA)	Point Data	Hammarstrom, J. M., Woodruff, L. G., & Dicken, C. (2024). Critical Mineral Deposits of the United States (ver. 2.0, April 2024). U.S. Geological Survey data release. https://doi.org/10.5066/P9K1HBNT	Mineral deposits in USA
Government (Canada)	Point Data	Government of Canada (2025). Critical Minerals advanced projects, mines and processing facilities in Canada	Critical Mineral Deposits in Canada
Government (USA)	Point and Polygon data	Nick A Karl, Jeffrey L Mauk, Tyler A Reyes, Patrick C Scott. (2020). Lithium Deposits in the United States.	Lithium deposits of the USA
Government (Ontario, Canada)	Permit Data	Geology Ontario - Spatial Search. Accessed August 2025.	Mineral Permits of Ontario
Government (Manitoba, Canada)	Permit Data	Business, Mining, Trade and Job Creation. Geo-Spatial Databases. Accessed August 2025.	Mineral Permits of Manitoba
Government (Quebec, Canada)	Permit Data	Quebec Data Partnership. Mineral Potential Interactive Map. Accessed August 2025.	Mineral Permits of Quebec
SOUTH AMERICA			
Academia	Point Data	da Silva, G. F., Gozalvez, M. R., Dias, D. A. D. S., da Silva, C. Y., Aravena, B., Rodriguez, D. E., Linares, E., Fernando, E., Vargas, G., Rivas, F., Aguilera, G., Muñoz, J., Turra, M., Ospina, M., Casallas, M., Larcher, N., Arrighetti, R., Torres, V., Garcia, V., & Wotruba, A. M. F. (2025). SAmMD: The South American mineral deposit database. Journal of South American Earth Sciences, 153, 105362. https://doi.org/10.1016/j.jsames.2025.105362	Mineral Deposits in South America, including Brazil, Chile and Argentina
Government (Brazil)	Permit Data	National Mining Agency, Ministry of Mines and Energy. SIGMINE. Accessed August 2025.	Mineral Permits of Brazil

Source	Type	Reference	Relevance
Government (USA)	Polygon and Point Data	Mihalasky, M.J., Briggs, D.A., Baker, M.S., Jaskula, B.W., Cheriyan, K., and DeLoach-Overton, S.W., 2020, Lithium Occurrences and Processing Facilities of Argentina, and Salars of the Lithium Triangle, Central South America: U.S. Geological Survey data release, https://doi.org/10.5066/P9RLUH4F.	Lithium deposits in Chile, Argentina
Government (Jujuy, Argentina)	Permit Data	Gobierno de Jujuy. Mining Cadastre. Accessed August 2025.	Lithium Permits of Jujuy, Argentina
Government (Salta, Argentina)	Permit Data	IDESA, Catastro Minero Salta. Accessed August 2025.	Lithium Permits of Salta, Argentina
Government (Argentina)	Point Data	Ministerio de Economía. Secretaría de Minería. Subsecretaría de Desarrollo Minero. Dirección Nacional de Promoción y Economía Minera. Cartera de Proyectos Mineros en Argentina del SIACAM. Accessed August 2025.	Lithium Mineral Data of Argentina

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