Cumulative impacts of copper and lithium mining in Argentina

International programme

External report OR/26/026

BRITISH GEOLOGICAL SURVEY

INTERNATIONAL PROGRAMME

EXTERNAL REPORT OR/26/026

Keywords

Lithium; Copper; Mining; Argentina.

Front cover

Evaporation ponds at Salinas Grandes salar, Argentina. BGS © UKRI 2026.

Bibliographical reference

H Grant, R T Halkes, E Petavratzi, A Hughes. 2026. Cumulative Impacts of Copper and Lithium Mining in Argentina. *British Geological Survey External Report*, OR/26/026. 52pp.

Cumulative impacts of copper and lithium mining in Argentina

H Grant, R T Halkes, E Petavratzi, A Hughes

Contributor/editor

R Shaw, G Mudd, C Woodward, J M Hannaford

Keyworth, Nottingham British Geological Survey 2026.

BRITISH GEOLOGICAL SURVEY

The full range of our publications is available from the BGS shop at Nottingham and Cardiff (Welsh publications only). Shop online at https://shop.bgs.ac.uk/

The London Information Office also maintains a reference collection of BGS publications, including fossils, for consultation.

We publish an annual catalogue of our maps and other publications; this catalogue is available online or from the BGS shop.

The British Geological Survey carries out the geological survey of Great Britain and Northern Ireland (the latter as an agency service for the government of Northern Ireland), and of the surrounding continental shelf, as well as basic research projects. It also undertakes programmes of technical aid in geology in developing countries.

The British Geological Survey is a component body of UK Research and Innovation.

British Geological Survey offices

Nicker Hill, Keyworth,
Nottingham NG12 5GG
Tel 0115 936 3100

BGS Central Enquiries Desk
Tel 0115 936 3143
email enquiries@bgs.ac.uk

BGS Sales
Tel 0115 936 3241
email sales@bgs.ac.uk

The Lyell Centre, Research Avenue South,
Edinburgh EH14 4AP
Tel 0131 667 1000
email scotsales@bgs.ac.uk

Natural History Museum, Cromwell Road,
London SW7 5BD
Tel 020 7589 4090
Tel 020 7942 5344/45
email bgslondonstaff@bgs.ac.uk

Cardiff University, Main Building, Park Place,
Cardiff CF10 3AT
Tel 029 2167 4280

Geological Survey of Northern Ireland, 7th Floor,
Adelaide House, 39-49 Adelaide Street, Belfast, BT2 8FD
Tel 0289 038 8462
www2.bgs.ac.uk/gsni/

Natural Environment Research Council, Polaris House,
North Star Avenue, Swindon SN2 1EU
Tel 01793 411500   Fax 01793 411501
www.nerc.ac.uk

UK Research and Innovation, Polaris House,
Swindon SN2 1FL
Tel 01793 444000
www.ukri.org

Website: https://www.bgs.ac.uk
Shop online: https://shop.bgs.ac.uk/

Foreword

This report is the published product of a study by the British Geological Survey (BGS) funded by the UK's Foreign, Commonwealth & Development Office (FCDO) through the Growth Gateway programme. It draws on information gained from meetings, workshops and site visits in Argentina in September 2025, plus a desk review and some focused stakeholder engagement. It is one of the BGS deliverables for the Growth Gateway programme across several countries during the 2025 to 2026 financial year.

BGS is a non-departmental public body and part of UK Research and Innovation (UKRI). BGS is the UK's premier provider of geological data, information and knowledge to help address major global challenges. BGS works globally to support UK foreign policy and trade partnerships and helps stakeholders use geological information and knowledge to improve decision making that underpins economy, environment and society. Much of BGS's current international work focuses on the UK's critical minerals strategy. The contents of this report does not necessarily reflect the position of BGS or the British Government.

BGS was hosted by Rio Tinto for a site visit at their Salar del Rincón lithium operations. This does not affect the findings of this report.

Acknowledgements

In addition to the BGS authors and editors, many individuals and organisations have contributed to the project, freely giving their advice and providing the local knowledge that is so important to this project. This assistance has been received at all stages of the study.

The team at the British Embassy in Argentina was invaluable in supporting and facilitating this and past work and we thank them for their efforts. We would especially like to thank Ms Jimena Carnelos for her support and friendship during our time working together for nearly a decade. Her insights and willingness to go above and beyond have contributed greatly to the success of our work over these years. We will miss working with her and remain deeply grateful for her collaboration.

We would especially like to thank Rio Tinto for hosting us at their operations in Salar del Rincón: the insights were invaluable for this project.

We are grateful to the following organisations and individuals for their time, knowledge and support: First Quantum, Panorama Minero (Lithium in South America Conference) and the University of Salta.

Finally, we would like to thank the BGS Graphics team for their support in preparing the maps for this report, which have greatly enhanced its clarity and presentation.

Contents

FIGURES

TABLES

Executive Summary

Lithium and copper underpin both sustainable development and the global energy transition. Both lithium and copper are critical for the manufacture of batteries used in electrification of transport and grid-scale energy storage; copper is also required for electrical wiring, transmission infrastructure, industrial machinery, and digital technologies. Given the importance of these two metals there is potential that mining these commodities in Argentina will have a significant cumulative impact in the provinces of Salta, Jujuy and Catamarca in northern Argentina.

To address these concerns, this work has used a combined desk-based research, field investigation, stakeholder engagement and geospatial analysis to assess the potential cumulative environmental and socio-economic effects of lithium and copper mining in Argentina. A comprehensive literature and data review formed the analytical foundation, drawing on geological, hydrogeological, environmental and governance studies, alongside project-level disclosures, environmental impact assessments (EIAs), company technical reports and existing BGS research in the ‘Lithium Triangle’. This enabled a detailed understanding of resource locations, resource characteristics, mining technologies and sustainability challenges.

Complementing the desk review, site visits and field observations were conducted in September and October 2025. These visits included Rio Tinto’s Salar del Rincón operation, allowing direct inspection of brine wellfields, direct lithium extraction (DLE) pilot facilities, water supply infrastructure, local geomorphology and monitoring systems. The visits provided essential contextual insight into operational practices, environmental sensitivities and logistical constraints in remote, high-altitude, arid environments.

Stakeholder engagement formed a third methodological pillar, involving discussions with mining companies, provincial authorities and researchers. These interactions provided nuanced perspectives on governance capacity, social dynamics, Indigenous participation, infrastructure pressures and emerging cumulative-impact concerns.

Finally, the study employed GIS mapping and spatial analysis using datasets from Servicio Geológico Minero Argentino (SEGEMAR) and the Secretaría de Energía to visualise project distribution, basin boundaries, hydrological systems and the spatial overlap between lithium salars, copper porphyry deposits and critical infrastructure.

Together, these methods enabled a multi-scale assessment, from individual project impacts to basin-wide interactions, capturing both technical and socio-political drivers of cumulative effects. The integrated approach ensures that any conclusions reflect real operational conditions, local governance realities and the complex interdependencies among water systems, ecosystems, communities and industrial development across Salta, Jujuy and Catamarca.

The case studies of Salar del Rincón, Salar del Hombre Muerto and Salar de Arizaro together illustrate the diverse but interconnected challenges associated with Argentina’s expanding lithium and copper industries. They highlight how cumulative impacts intensify across scales from single-operator salars to multi-operator basins and mixed mineral districts.

Salar del Rincón represents a rapidly evolving lithium project transitioning from early development to large-scale production, centred around deployment of DLE. The Rincón case demonstrates how even a nominally ‘single-operator’ salar can quickly become a multi-stakeholder system due to adjacent tenements, overlapping water demands and shared infrastructure needs. The site visit revealed extensive brine and freshwater wellfields, highlighting pressures on a hydrologically delicate environment where recharge is minimal and ecological receptors, particularly wetlands and lagunas, are sensitive to drawdown and salinity shifts. The case also underscores the significant associated logistical requirements, including energy supply, chemical transport and management of a remote site. Social considerations include the importance of community engagement, Indigenous relationships with salar landscapes, workforce health at altitude and the broader need to maintain trust and social licence.

In contrast, Salar del Hombre Muerto provides an example of a mature, multi-operator lithium basin where cumulative impacts are already manifest. Production has continued for nearly three decades and the basin now hosts several operators at different stages of development, including long-established lithium production systems, ongoing expansions and new entrants. This concentration of activity amplifies pressures on shared water resources, particularly the Río de los Patos and Río Trapiche systems, and has raised concerns regarding ecological impacts on wetlands and flamingo habitats. Governance complexity is substantial, with the salar straddling provincial boundaries between Catamarca and Salta. A 2024 court ruling requiring a cumulative impact assessment reflects growing recognition that project-level EIAs cannot capture basin-wide hydrological and social interactions. Social tensions in the region reflect a combination of environmental concerns, uneven consultation processes and perceived inequities in benefit distribution, set against the economic dependence many communities have on mining-related infrastructure and employment.

The third case study, Salar de Arizaro, introduces copper into the analysis and demonstrates how porphyry copper mining interacts with lithium development within the same high-Andean hydrological systems. The proposed large-scale, open-pit mine will require substantial volumes of fresh water for milling and flotation as well as brine for tailings management, drawing from the same aquifer systems that are also proposed for use for potential nearby lithium operations. The coexistence of copper, lithium and gold projects in the Arizaro basin highlights a new frontier of cumulative impacts where cross-commodity competition for scarce water, infrastructure corridors and regulatory attention is likely to intensify.

Together, these case studies demonstrate that cumulative effects arise not only from multiple lithium projects within a single salar but also from the growing overlap between lithium and copper activity across broader basin systems. They illustrate why basin-scale hydrological understanding, integrated infrastructure planning, robust governance and coordinated monitoring frameworks are essential for managing Argentina's critical mineral expansion responsibly.

SUMMARY FINDINGS

Cumulative impacts

Cumulative impacts are a central challenge for Argentina's lithium and copper expansion. Argentina's regulatory system focuses on individual project EIAs rather than basin-scale assessment, resulting in several gaps:

- hydrological linkages between brine and freshwater aquifers are rarely assessed at system scale
- multiple projects within a single salar, or basin, can generate additive or amplifying impacts that project-level EIAs cannot detect
- overlap between copper and lithium projects, especially in basins such as Salar de Arizaro, intensifies cross-commodity pressures on water, land and energy
- baseline environmental datasets remain inconsistent, incomplete, or proprietary, limiting the ability to model cumulative impacts

Water scarcity

Water scarcity is the principal constraint for both sectors. Across all case studies, water emerges as the key factor shaping environmental and social risk:

- freshwater and brine sources are already under significant stress in many basins
- re-injection (associated with DLE) remains poorly understood, with limited data on long-term hydrogeological outcomes
- surface water systems, such as the Río Los Patos at Salar del Hombre Muerto, show signs of ecological stress resulting from combined abstraction

Governance

Governance capacity and coordination remain fragmented. Varying and constrained governance and technical capacity limit oversight of cumulative impacts:

- provinces often lack the hydrogeological and monitoring capabilities needed for basin-scale impact evaluation
- monitoring networks and environmental disclosure are not harmonised across provinces or operators
- implementation of Indigenous consultation is uneven, contributing to mistrust and conflict
- cross-border (inter-provincial) coordination exists, for example lithium roundtable (mesa de litio)but would benefit from further support.

Infrastructure

Infrastructure development presents both risks and opportunities. Mining expansion requires substantial new infrastructure, which can either exacerbate or help manage cumulative impacts, depending on how it is planned and developed:

- projects require roads, power lines, supply corridors, airstrips and water infrastructure, all of which can unnecessarily increase land disturbance if developed independently
- shared or coordinated infrastructure could reduce environmental footprints, improve efficiency, and deliver broader benefits to local communities
- lack of integrated planning increases the risk of duplicated or competing infrastructure corridors across the same sensitive basins

Key recommendations

- Strengthen environmental and social impact assessment (ESIA) processes to address basin-scale cumulative impacts:
  - develop a basin-wide cumulative-impacts framework and update ESIA requirements to assess all mining activities within a basin together
  - clarify legislative needs, improving provincial technical capacity and identify key bottlenecks (data; methods; institutional arrangements)
  - define how project-level ESIAs interface with strategic environmental assessments (SEAs) and basin-scale cumulative impact assessments (CIAs) and pilot approach

- Establish a lithium salar observatory and open-data platform:
  - develop a salar with research-focussed monitoring and associated digital platform to provide long-term hydrological, geochemical and ecological data
  - ensure transparent access for regulators, researchers and communities, with links to regional initiatives

- Establish a lithium salar observatory and open-data platform:
  - create an instrumented salar and associated digital platform to provide long-term hydrological, geochemical and ecological data
  - ensure transparent access for regulators, researchers and communities, with links to regional initiatives

- Assess DLE and re-injection impacts:
  - conduct quantitative evaluation of DLE and re-injection effects on basin hydrodynamics, lagunas, wetlands and biodiversity
  - include assessment of water use, energy and chemical needs and carbon footprint to determine the true environmental trade-offs of DLE

- Plan shared, multi-operator infrastructure at corridor scale:
  - develop coordinated infrastructure plans (power; water; roads; rail; communications) to reduce duplication, land disturbance and costs
  - identify opportunities for shared transmission lines, transport corridors and logistics infrastructure
  - apply environmental design standards and incorporate community benefit-sharing where appropriate

1 Introduction

1.1 LITHIUM AND COPPER – GLOBAL OUTLOOK

Lithium (Li) and copper (Cu) underpin both sustainable development and the global energy transition. Lithium and copper are critical for the manufacture of batteries used in electrification of transport and grid-scale energy storage; copper is also required for electrical wiring, transmission infrastructure, industrial machinery, and digital technologies. The UK classifies lithium as both a Critical and Growth mineral, and copper as a Growth mineral (Mudd et al., 2024; DBT, 2025), reflecting the importance of these metals.

In 2024, lithium demand grew 30 per cent year-on-year to reach around 1.1 million tonnes (Mt) lithium carbonate equivalent (LCE), which is an increase equivalent to the global demand in 2018 (IEA, 2025). However, this was outpaced by production, which increased by more than 35 per cent, shifting the market towards oversupply. As such, the market is expected to remain well supplied in the near term, but new mining projects are still necessary to meet future demand growth (IEA, 2025). Currently, South American lithium supply is dominated by Chile, although 70 per cent of future supply from the region is expected to come from Argentina. Some of this is from new projects, although the largest growth in supply is expected to come from the scale-up of current producers (IEA, 2025).

Global copper mine production reached 22.8 Mt in 2024 (**Error! Reference source not found.**). Chile remained the largest producer, followed by the Democratic Republic of the Congo (DRC), which continued to expand its mine production to replace Peru as the world's second-largest producer of mined copper. China dominates global refined production (Idoine et al., 2024; IEA, 2025).

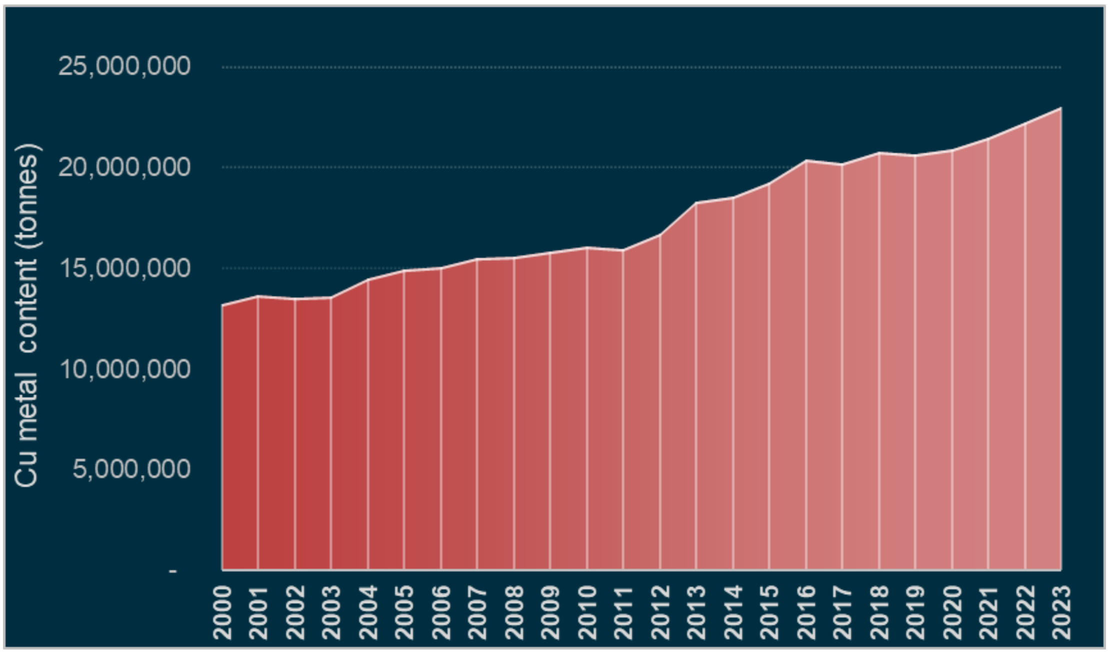

Figure 1 Global copper mine production. Data from BGS World Mineral Production (Idoine et al., 2024). BGS © UKRI 2026.

Copper mine production has increased 5-fold in the past 23 years from 554 kt in 2000 to 2 755 kilotonnes (kt) in 2023. Predictions indicate global mine production will peak in the late 2020s at just over 24 Mt, after which production is set to decrease to less than 19 Mt by 2035 due to declining ore grades, asset retirements and reserve depletion (IEA, 2025). Major near-term growth is expected to come from the DRC; although there is also predicted near-term growth in copper production from South America, this does not currently include any significant production from Argentinian deposits. Collahuasi (Chile), Quebrada Blanca (Chile) and Las Bambas (Peru) dominate near-term growth in South America. There are numerous large exploration projects in the pipeline in South America, if some of these projects become operational (such as Argentinian prospects), then the growth patterns in the region are likely to have different trajectories.

While lithium and copper are indispensable to global sustainable development and decarbonisation, scaling production for responsible and resilient global supply chains requires strong environmental, social and governance (ESG) conditions to avoid undue environmental and social impacts, which in turn can exacerbate supply risk.

1.2 ARGENTINA'S MINING INDUSTRY AND POTENTIAL

Argentina is one of the largest economies in South America, yet its mining sector remains relatively underdeveloped. Large-scale mining activity only began in the mid-1990s and, historically, the country has not been a major player in global mineral production. However, there has been an increasing drive in recent years to expand the sector, supported by legislative changes and financial incentives (Guajardo, 2025).

In 2018, the extractive sector contributed (EITI, 2022):

- 3.84 per cent to total government revenue
- 10.8 per cent to exports
- 4.2 per cent to GDP

In 2024, mineral exports were valued at US$4.7 billion (or 5.9 per cent of Argentina's total exports). However, it is estimated that 70 per cent of the country has not been systematically explored; it is also estimated that Argentina contains resources that could deliver exports worth US$18 billion per annum by 2030 (ITA, 2023; Secretariat of Mining, 2024). Gold and silver have traditionally been the basis of Argentine mining exports, accounting for 70 per cent and 14 per cent of total mining exports in 2024, respectively (BBVA, 2025). Lithium and copper (alongside gold and silver) are expected to see future export growth, with lithium exports expected to witness an eight-fold increase in the next five years (Secretariat of Mining, 2024, 2025). Figure 2 shows current advanced-stage exploration projects and mining operations in Argentina (Secretaría de Energía, 2025; SEGEMAR, 2026).

This expected increase in output is due to Argentina being one of the 'Lithium Triangle' countries alongside Bolivia and Chile, with Argentina reportedly hosting the second largest lithium resources in South America (Secretariat of Mining, 2024). Production at Salar del Hombre Muerto has been ongoing for nearly three decades, and Argentina's regulatory framework has begun to position it as a strong investment destination (ITA, 2023) with numerous projects in the pipeline. Six projects are at production stage (Cauchari - Olaroz, Centenario - Ratones, Fénix, Mariana, Olaroz, Sal de Oro), five under construction (Hombre Muerto Oeste, Rincón, Sal de Los Ángeles, Sal de Vida, Tres Quebradas) and four projects at feasibility stage (Kachi, Pastos Grandes, Pozuelos (PPG), Salar del Rincón). Three projects are undergoing pre-feasibility studies (PFS) with four projects at the preliminary economic assessment (PEA) stage (Secretariat of Mining, 2025a).

Argentina produced copper from the Bajo de la Alumbrera mine in Catamarca Province from 1997 until the mine closed in 2018. Currently, Argentina produces a small amount of copper from one small-scale mine in Jujuy Province (Martín Bronce) that has been operating since the early 2020s (Canning House, 2024). Table 1 summarises the status (as of March 2026) for advanced stage copper projects in Argentina. One project is under construction (Josemaria), three projects are at feasibility study stage (Taca Taca, Mara, El Pachón), two are at pre-feasibility (San Jorge and Filo del Sol) and one project (Loz Azules) is undergoing preliminary economic assessment.

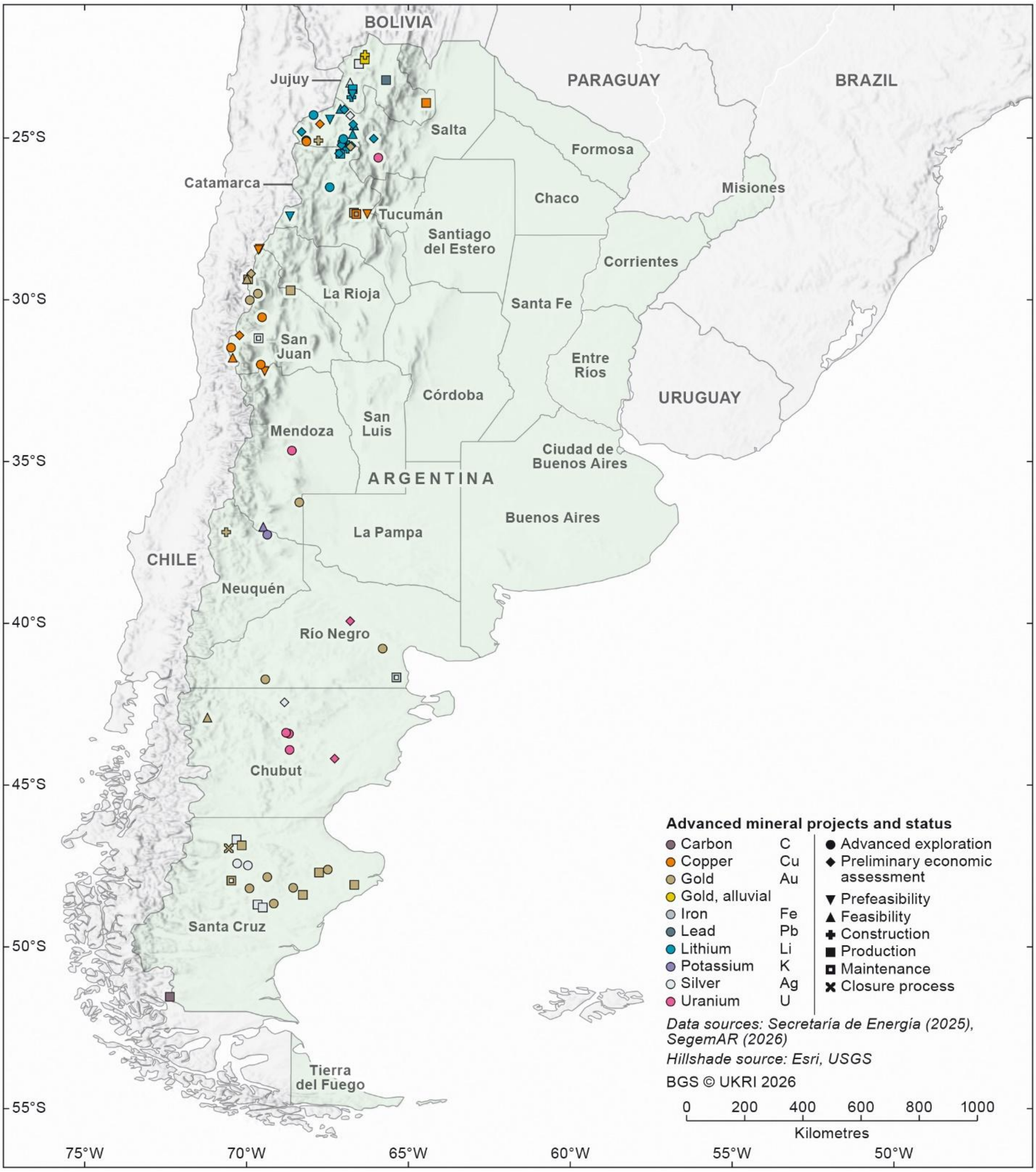

Figure 2 Advanced-stage exploration projects and mining operations in Argentina. Province names and boundaries are also displayed. Adapted from GIS data from Secretaría de Energía (2025) and SEGEMAR (2026). BGS © UKRI 2026.

Table 1 Summary table of Argentina's lithium and copper projects (Secretariat of Mining, 2025).

Commodity	Total Projects	Production	Construction	Feasibility	PFS	PEA	Advanced Exploration
Copper	24	1	1	3	2	1	16
Lithium	47	6	5	4	3	3	26

Even though copper production is still nascent in Argentina, the geological potential is significant and comparable to Chilean districts (BBVA, 2025). It is estimated that the total potential copper *resources* could be in the region of 247 Mt (Secretariat of Mining, 2024). It should be noted that mineral resource estimates reflect reasonable prospects for eventual economic extraction, but commercial viability is not yet proven. For comparison, Chilean Cu *reserves* (i.e. portions of deposits proven to be economically viable for extraction) are reported as 180 Mt (USGS, 2026). There is potential to produce other metals from Argentinian Cu deposits, such as cobalt (Co), molybdenum (Mo), tellurium (Te) and gold (Au) as co- or by-products of primary copper mining, but there has been limited in-depth assessment of this potential in Argentina (Murguía and Bastida, 2023).

Current lithium projects in Argentina are primarily concentrated in the provinces of Salta, Catamarca and Jujuy (Figure 2 and Figure 3) in addition to multiple copper projects. This report will therefore primarily concentrate on these three provinces in order to explore potential cumulative impacts from both lithium and copper mining.

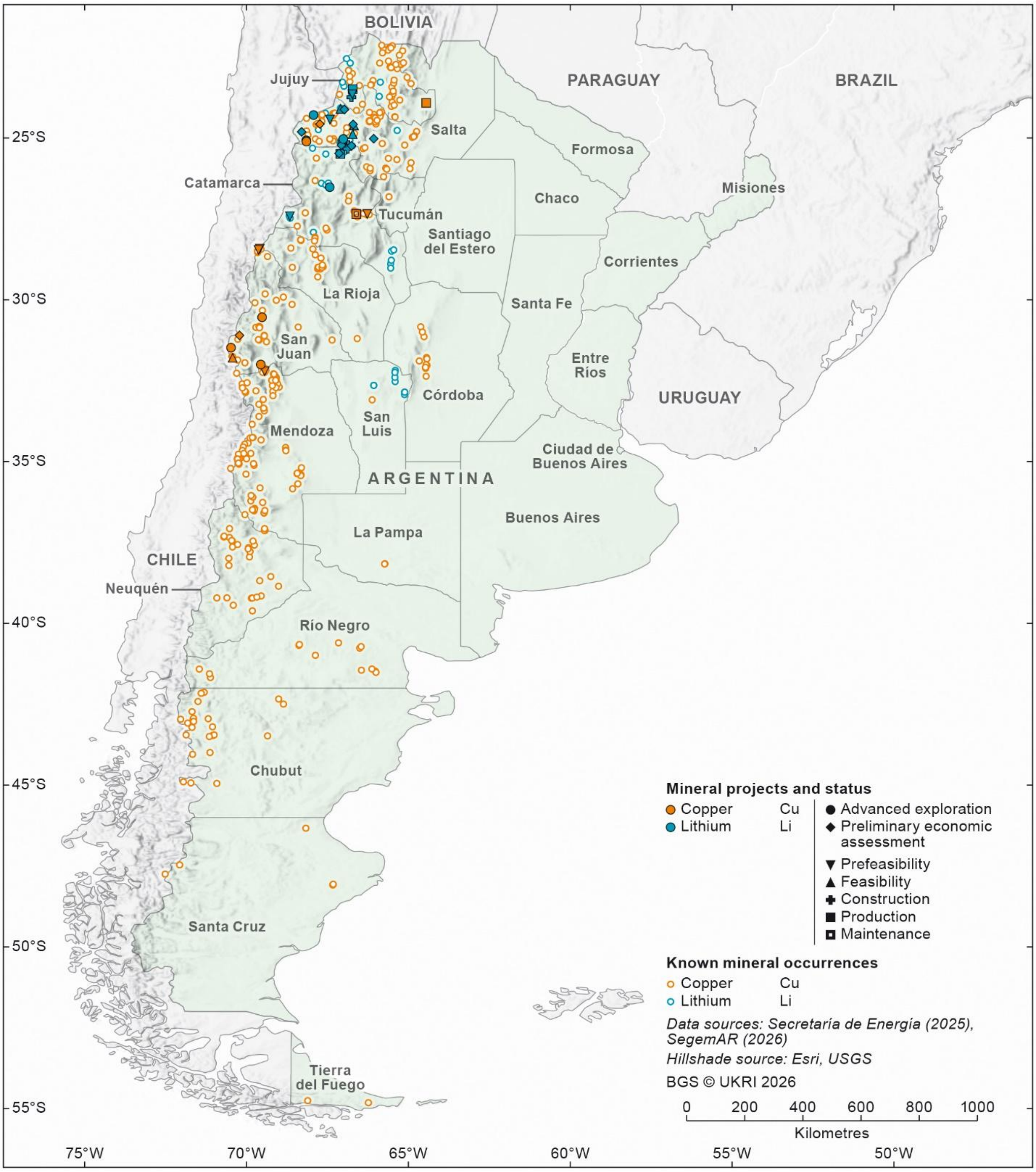

Figure 3 Known lithium and copper projects and occurrences in Argentina. The current project status as of January 2026 for projects at or beyond advanced exploration are also shown. Adapted from GIS data from Secretaría de Energía (2025) and SEGEMAR (2026). BGS © UKRI 2026.

2 Overview of Argentina’s Mining System

Argentina is constitutionally organised as a federal state comprising 23 provinces (Figure 2). The main legislation relevant to the mining industry includes (Guajardo, 2025):

- Mining Code (Law 24,585): establishes the rights, obligations and procedures governing exploration and production
- Mining Investment Law (Law 24,196): provides fiscal stability for 30 years, import tax benefits and accelerated depreciation incentives for capital investments
- National Geological Information Bank (Law 24,466): promotes transparency and standardised access to geological data
- Large Investment Incentive Regime (RIGI, decrees 234/21 and 836/21): offers long-term regulatory and tax stability for projects exceeding specified investment thresholds
- General Environmental Protection Act (Law 25,675)

The Mining Investment Law is supported by bilateral investment treaties with countries such as Australia, Canada, China, South Africa and the USA, as well as the Foreign Investment Law, which grants equal treatment to foreign and domestic investors. There are currently no restrictions concerning foreign investment and ownership of companies engaged in exploration and extraction activities (Secretariat of Mining, 2025).

In 2024, Argentina introduced the ‘Régimen de Incentivo para Grandes Inversiones’ (Incentive Regime for Large Investments) or RIGI. RIGI is aimed at projects with a minimum investment of US$200 million to US$900 million. It provides incentives for large-scale investments, including ones related to VAT and income tax and exemptions from import and export duties, among others (Secretariat of Mining, 2025).

At the federal level, the Secretariat of Mining within the National Ministry of Productive Development is the national authority (Dentons, 2022). SEGEMAR is the national geological survey, hosted within the Secretariat of Mining. The Federal Mining Council (COFEMIN) was created to design and execute the national mining policy (Secretariat of Mining, 2025). There is also the Argentine Chamber of Mining Companies, which represents mining companies, as well as provincial chambers and suppliers.

Provinces are the owners of natural resources and most have their own mining codes. Generally, these follow the National Mining Code, but provinces also have their own regulations, such as environmental legislation (Dentons, 2022; Murguía and Bastida, 2023). The provinces are responsible for granting exploration and extraction rights, charging royalties and other non-fiscal contributions and ensuring compliance with environmental regulatory frameworks (Secretariat of Mining, 2025). Each province has its own authority that controls mining within the territory. Usually, this is subordinate to the provincial executive branch. However, in some provinces (such as Salta), they are subordinate to the judicial branch (Secretariat of Mining, 2025).

The National Lithium Board was created in 2021 by the governors of Salta, Jujuy and Catamarca to channel ideas, projects and proposals. The Copper Board is made up of the governments of Salta, Jujuy, Catamarca, San Juan and Mendoza provinces. The Copper Board’s main purpose is to coordinate public policies for economic and social development derived from research into and extraction, production, industrialisation and commercialisation of copper and its products.

In 1997, Argentina and Chile signed the Mining Treaty. This establishes a mechanism for cooperation to allow cross-border development of deposits, covering an area of more than 200 000 km^2. Most of the projects covered by the treaty are in Argentina’s San Juan province or Chile’s Atacama and Coquimbo regions. Copper projects, such as Josemaría, Lunahuasi, Filo del Sol, Los Helados, Los Azules and El Pachón, have reportedly benefited from the treaty (BNamericas, 2024).

Argentina has made a concerted effort to adopt certification schemes and best practices in the mining sector, including joining the Extractive Industries Transparency Initiative (EITI) in 2019. Several provinces, including Catamarca, Salta and Jujuy, have joined the EITI, as has the federal government. As part of its broader transparency agenda, Argentina has strengthened the systematic disclosure of mining-related information through the Sistema de Información Abierta a la Comunidad sobre la Actividad Minera en Argentina (SIACAM) (Open Community Information System on Mining Activity in Argentina). Launched in 2022, SIACAM is a public mining information platform that provides detailed social, economic and environmental data on mining activities (EITI, 2022; Secretariat of Mining, 2025). The federal government was also one of the first adopters of the Mining Association of Canada's 'Towards Sustainable Mining' (TSM) initiative (Mining Association of Canada, 2016).

Argentina is a signatory to the Escazú Agreement related to environmental justice in the region, which is enshrined in the Argentine Constitution. Argentina has also ratified the Indigenous and Tribal Peoples Convention of 1989 (ILO Convention 169), under which Indigenous communities have the right to be recognised by the authorities (at federal and provincial level) as entities with legal status. As such, they can exercise collective rights, such as community ownership of the lands they inhabit and of the natural resources (Dentons, 2022). While regulation is strong, implementation can be complex.

Environmental requirements are set out in the Environmental General Protection Act N° 25,675 and Law No. 24,585, incorporated into the Mining Code (Secretariat of Mining, 2025). Individuals or entities seeking to prospect, explore or mine must submit an environmental impact assessment (EIA) to the provincial authority. If the EIA meets the required quality standard, an environmental impact statement (EIS) is issued. The EIS is issued for two years and establishes a set of conditions and requirements that must be complied with. Mining companies must submit updates of the EIS every two years after its initial approval (Secretariat of Mining, 2025).

When quoting published mineral resources or reserves in this report and where available, reference will be made to reports adhering to standard global reporting codes such as the National Instrument (NI) 43-101 reporting code (Canadian) or the Australian JORC mining code. These codes set mandatory standards for disclosing scientific and technical information about mineral projects, including mining reserves and resources. The codes require reports to be prepared by independent qualified professionals to ensure accuracy, transparency and consistency for investors.

3 Lithium and Copper and Cumulative Impacts

3.1 INTRODUCTION TO LITHIUM SALAR DEPOSITS

Salars are among the most complex natural systems in the world, subject to interacting geological, climatic, geochemical, hydrological and hydrogeological factors (Munk et al., 2016). High Andean salars (salt flats: from the Spanish *salar*, pl. *salares*) are the remnants of ancient lakes occupying closed basins that have experienced prolonged aridity, nearby igneous or hydrothermally sourced lithium inputs and long timescales for solute concentration. Lithium is leached from surrounding volcanic deposits and transported into the salars by surface- and groundwaters, then subsequently concentrated by evaporation (Rossi et al., 2022); the formation of lithium-rich brines by this process can require timespans of the order of 100 000 years (Corenthal et al., 2016).

Structurally, a salar can be divided into the nucleus and the transitional (or marginal) zone, which is contained within the wider basin (Figure 4). The nucleus comprises sedimentary deposits of clays, silts, sands and evaporitic minerals. Transitional margins host fresher and brackish groundwaters, and support wetland ecosystems (lagunas; vegas) that are culturally and biologically significant.

Rainfall is typically very low on the salars, in the order of tens of millimetres per annum, rising to hundreds of millimetres per annum as elevation increases away from the salar (Marazuela et al., 2018). Direct rainfall recharge to the nucleus is therefore limited or absent. Surface water and groundwater inflows, while small in volume, are critical for maintaining fresh and brackish surface-water systems. Outflows are dominated by evaporation, which exceeds precipitation by an order of magnitude (Godfrey et al., 2013). This evaporative concentration of inflowing waters is the primary mechanism that produces lithium-rich brines: abstraction, whether for potable supply, industrial use or brine extraction, draws on a system with very limited natural recharge.

Most commercial salar operations follow a three-stage sequence:

> brine abstraction → concentration and purification → conversion to lithium carbonate (Li_2CO_3) and/or lithium hydroxide monohydrate ($LiOH{\cdot}H_2O$)

Two principal processing technologies are employed: evaporation processes and direct lithium extraction (DLE) (Figure 4).

During evaporation processes, solar and wind-driven evaporation progressively concentrates the brine in a succession of evaporative ponds. Different intermediate salts may be harvested as they precipitate and impurities removed (Flexer et al., 2018). Evaporation has a lithium recovery rate of 40 to 60 per cent and 85 to 95 per cent of the water contained within the brines is lost through evaporation (Flexer et al., 2018; Nicolaci et al., 2023). Fresh water is also consumed in the process (Kelly et al., 2021).

DLE is a blanket term referring to a growing number of technologies that actively concentrate lithium from brine without the need for large evaporation ponds (Nicolaci et al., 2023; Vera et al., 2023). DLE processes achieve higher lithium extraction efficiency of 70 to 90 per cent and have a significantly reduced surface footprint compared to evaporation processes (Fuentealba et al., 2023; Nicolaci et al., 2023; Farahbakhsh et al., 2024). DLE requires energy, fresh water and chemicals that must be considered in EIAs; pre- and post-treatment of brines and concentrated lithium solutions may be necessary (Vera et al., 2023). With DLE, it is possible to re-inject a significant proportion of the abstracted brine to the salar, potentially helping to mitigate impacts on environmentally sensitive locations such as lagunas (Figure 4).

Salar systems are extremely sensitive and unique. They host Indigenous communities and globally significant and precious ecosystems of high cultural and symbolic value and biodiversity (Marazuela et al., 2019; Bonelli and Dorador, 2021; Gutiérrez et al., 2022; Lorca et al., 2022). Salars are often within, or in proximity to, Ramsar sites (wetlands designated to be of national and international importance), national parks, Key Biodiversity Areas (Stacey, 2019) or other protected and valuable areas.

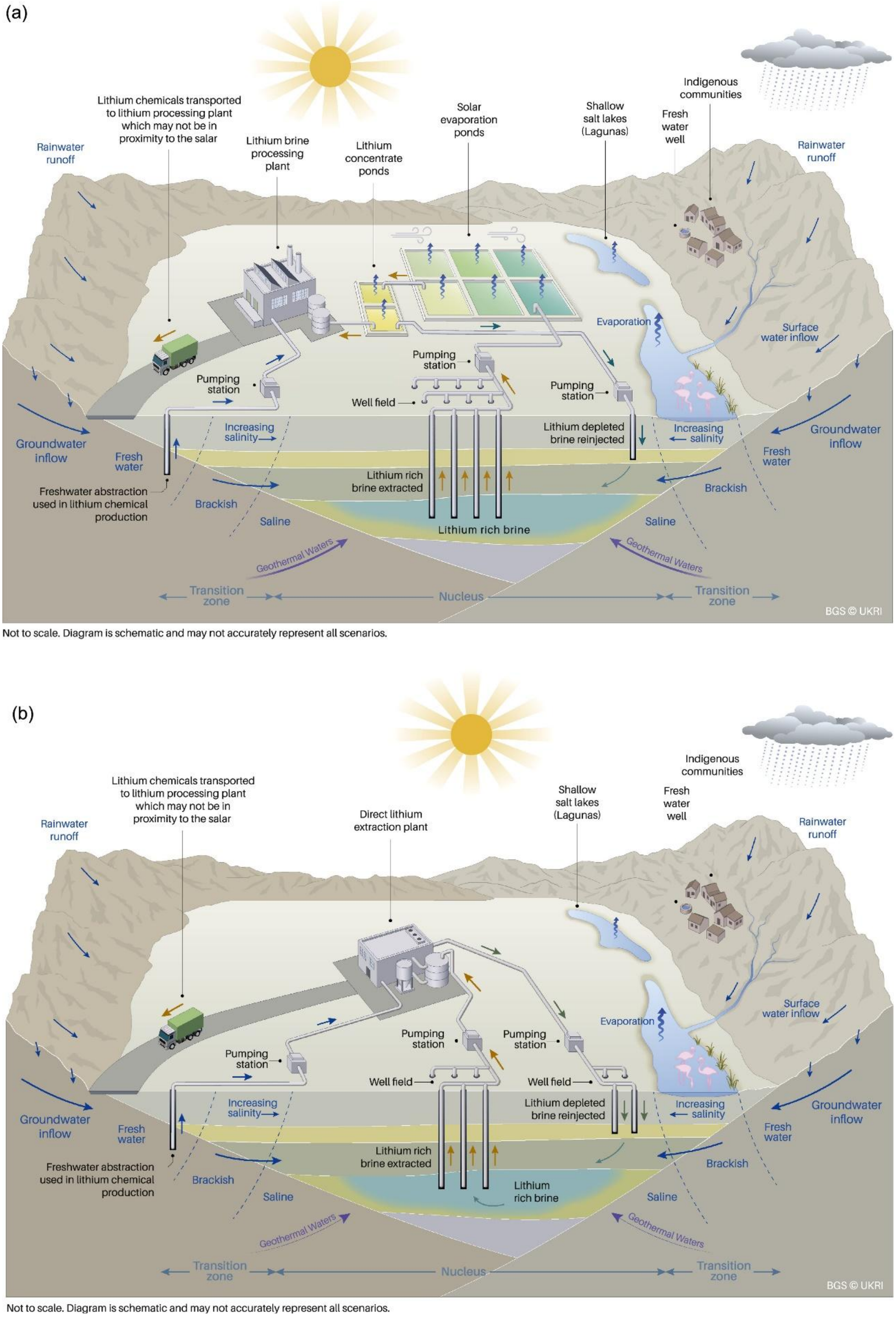

Figure 4 Schematic block diagram of a salar illustrating brine extraction and concentration with (a) evaporation ponds and (b) DLE. Hydrogeological and other salar features are also displayed. Diagram is not to scale and is schematic, so may not accurately reflect all scenarios. Position and nature of extraction and re-injection is indicative and may not accurately reflect actual practices. From Halkes et al. (2024a). BGS © UKRI 2026.

Water use is the most significant sustainability concern of lithium production from salars, which potentially reduces water availability to local communities and sensitive ecosystems (Marazuela et al., 2019; Gutiérrez et al., 2022; Lorca et al., 2022; Díaz Paz et al., 2023). Impacts will be unique to each salar and project, with the hydrogeology, hydrology, geomorphology, geology, elevation and technology used all influencing how impacts materialise (Flexer et al., 2018; Munk et al., 2021).

Brine abstraction can affect the inflow of fresh water from salar margins or depth and, therefore, potentially the availability of fresh water in the wider system, but there is no linear relationship between brine abstraction and decreases in water storage (Marazuela et al., 2019). Fluctuations in the water table and brine concentration, influenced by re-injection as well as abstraction, can affect the evaporation rate (Houston, 2006; Marazuela et al., 2019). In turn, this could impact a salar's hydrogeology, especially brine circulation, freshwater inflow, the position of the brine/freshwater interface (Rosen, 1994; Marazuela et al., 2019) and subsequently lagunas, ecosystems and the availability of fresh water to communities.

Mining operations also often have separate supplies of fresh water, with the potential to directly reduce groundwater levels, thus affecting water availability to ecosystems and communities as well as introducing salinity into freshwater parts of the system (Herrera et al., 2016; Petavratzi et al., 2022). Freshwater abstraction is thought to have a direct and larger impact than brine abstraction on wetlands, lagunas and freshwater resources (Moran et al., 2022). However, it should be noted that, in some areas, the fresh water may not be suitable for human consumption without further treatment (Concha et al., 2010; Flexer et al., 2018).

3.2 INTRODUCTION TO ARGENTINIAN COPPER DEPOSITS

The vast majority of Argentina's copper deposits are hosted in porphyry systems, which are large, low-grade (typically 0.2 to 1 per cent copper) magmatic-hydrothermal deposits formed in continental arcs above subduction zones (Sillitoe, 2010). They represent the world's most important source of copper, accounting for approximately 75 per cent of global production, and are often associated with significant amounts of other metals (co- and by-products) such as molybdenum, gold and silver (Mudd et al., 2013). In the central Andes, porphyry copper deposits are spatially associated with late Oligocene to Pliocene (around 25 to 6 million years old (Ma)) magmatic arcs at high elevations, typically 3500 to 5000 metres above sea level (masl) in arid to hyper-arid environments (Sillitoe and Perelló, 2005).

The term 'porphyry' describes the distinctive texture of the igneous (volcanic) rocks that host these types of mineral deposits. The host rocks are characterised by a fine-grained matrix containing large, distinct crystals ('phenocrysts'). The ore bodies are characterised by a central porphyritic, volcanic rock mass surrounded by concentric zones where the original host rocks have been altered by hydrothermal processes (the actions of heated water in the Earth's crust) and coeval or later mineralisation. Individual deposits can range from a few hundred million to several billion tonnes of ore. Hypogene (deep) sulfide mineralisation, copper-iron and molybdenum sulfides such as chalcopyrite and molybdenite are typically overprinted at shallower depths by a supergene (near-surface) enrichment in which secondary copper sulfides (chalcocite; covellite) or copper oxide minerals (malachite; azurite; chrysocolla) may be present, the latter particularly amenable to heap-leach processing (Sillitoe, 2010). Deposits with greater abundances of secondary sulfide or oxide minerals will typically give higher grades due to a higher percentage of copper hosted in these secondary minerals.

Copper porphyry deposits may also be spatially close to or overprinted by high-grade epithermal mineralisation. Epithermal deposits related to porphyry emplacement can be potentially rich in metals such as gold, silver, copper, lead and zinc. This type of mineralisation forms in faults and fractures at shallower crustal depths and lower temperatures compared to porphyry deposits, and can significantly add to copper grades and tonnage. As an example, the Argentinian Filo del Sol copper project in San Juan Province is one of the most significant undeveloped copper-gold-silver resources globally and is hosted by an epithermal copper-gold-silver deposit that is closely associated with a larger but lower grade, underlying copper-gold porphyry system (Perrelló et al., 2023).

Large-scale porphyry (and associated epithermal) deposits are typically mined by large open-pit, truck-and-shovel methods involving extensive drilling, blasting and bulk handling of mineralised material and waste rock. Waste rock and overburden volumes substantially exceed ore volumes; the resulting waste rock dumps and tailings storage facilities (TSFs) dominate the physical footprint of operations (Mudd, 2010).

The standard processing route for sulfide ores is comminution (crushing and grinding) followed by froth flotation to produce copper and molybdenum concentrates, which are then smelted and refined off-site (depending on mine infrastructure). Flotation circuits require large volumes of water and reagents and produce fine-grained tailings that must be managed in engineered TSFs (Kinnunen and Kaksonen, 2019). Oxide ores, where present, may be processed separately by heap leaching and solvent extraction-electrowinning, a hydrometallurgical route that can recover copper at lower grades and with a reduced water footprint relative to flotation (Schlesinger et al., 2011). Concentrate impurities — particularly arsenic, which is common in some Andean porphyries — create both commercial and ESG challenges, as high arsenic levels can reduce smelter acceptability, produce smelter penalties for the operator and increase environmental and residue-management risks (Dold and Fontboté, 2001).

Large porphyry and epithermal systems host the vast majority of known copper deposits in Argentina; however, the only producing copper mine at the time of this report is the high-grade Martín Bronce copper-gold project in Jujuy Province, which is neither porphyry or epithermal-hosted (MOM Mining, 2026). This deposit was historically worked both at the surface and underground, with the most recent production recommencing in approximately 2022 (Panorama Minero, 2024). The copper-bearing sediment-hosted ore body has a grade of approximately 5 per cent copper. Bulk ore production is currently 300 to 400 tons monthly and is being exported directly to Chile (Panorama Minero, 2024). The small scale of the production should be noted compared to the estimated bulk production of over 3 Mt per month for Stage 1 of the Taca Taca porphyry deposit (Section 0). Due to the magnitude of difference in potential production scales and cumulative impacts, Argentinian sediment-hosted copper deposits are not considered further in this report.

Porphyry copper mining generates a broad range of environmental impacts, several of which are particularly acute in high-altitude Andean settings. The dominant concerns are water use and contamination, physical disturbance and land-use change, and management of potentially acid-generating waste rock and tailings.

Given the severe aridity of the high Andes, water supply is a critical constraint for porphyry copper operations. Several projects, such as the Vicuña joint venture between BHP and Lundin Mining (San Juan Province), are evaluating or have adopted sea water or desalinated water supply pipelines from the Pacific coast of Chile to reduce their reliance on scarce highland fresh water, trading lower water-conflict risk for higher energy intensity and infrastructure costs. Recirculation of processed water and dry-stack tailings technologies are being increasingly considered by operators to reduce their consumption of fresh water and TSF risk (Section 0).

Water consumption for milling and flotation at large porphyry operations is substantial and, in arid areas, this demand can interact with local and regional agricultural, domestic and ecosystem water needs. Acid rock drainage (ARD) from waste rock dumps and TSFs is a long-term risk where sulfide minerals are exposed to oxidising conditions; if unmanaged, ARD can mobilise heavy metals and acidify surface- and groundwaters over decadal to centennial timescales (Lottermoser, 2010). TSF failure represents a low probability but high consequence risk in the seismically active Andean regions: dam-break events have resulted in some of the most severe mine-related environmental disasters on record globally (for example, Buenavista del Cobre, Mexico, 2014; Brumadinho, Brazil, 2019), emphasising the importance of robust geotechnical design and monitoring.

At high elevations, porphyry operations may affect glaciers, permafrost and peri-glacial hydrology, which serve as critical water stores for downstream communities and ecosystems. Argentina's Ley de Glaciares (Glacier Law; No. 26,639) prohibits activities that could affect periglacial environments and glaciers and has been a significant source of legal dispute for mining projects in glaciated Andean settings (Taillant, 2015). Dust generation from open-pit operations, haulage roads and waste facilities can affect air quality and deposit on soils and water bodies, with potential toxicological consequences where metal-bearing dusts are involved.

Socially, large-scale open-pit operations require significant land access, infrastructure development and workforce mobilisation, generating both opportunities and tensions for host communities. Indigenous consultation obligations under ILO Convention 169 and domestic Argentine law apply to projects affecting Indigenous territories and have been the subject of legal challenge and community conflict in several Andean provinces.

3.3 OVERVIEW OF LITHIUM AND COPPER MINING IMPACTS

Social and political disputes around large-scale metalliferous mining and its impacts have resulted in several provinces banning certain mining techniques, such as open-pit mining (EITI, 2022). Literature from international scientific sources and Argentina-based organisations identifies water access and broader socio-economic concerns, including employment, human rights and sociotechnical development, as central issues associated with mineral extraction in the region (Díaz Paz et al., 2023). Although lithium brine extraction and copper mining rely on different techniques, both can generate significant environmental and social pressures, most notably on water resources. The two deposit types differ in the nature of the ore and the character of the operational footprint, yet they share common landscape and socio-environmental contexts.

Porphyry copper operations move very large volumes of rock: drilling, blasting, hauling and milling are central activities and TSFs typically dominate the long-term land disturbance and risk envelope alongside the open pit and plant infrastructure. By contrast, salar lithium operations involve no blasting; the ore is a mobile brine. The disturbance footprint arises from wellfields, evaporation pond infrastructure or DLE processing plants, pipelines and, where used, re-injection systems. Evaporation ponds can be extensive but are — in principle — reversible; wellfield and plant footprints are generally more modest.

Both deposit types impose significant water demands on landscapes where fresh water is scarce. Copper operations require fresh water for grinding, flotation and dust suppression; in arid zones, projects increasingly deploy sea water or desalination as the primary supply, reducing competition with local users but increasing energy intensity. Lithium operations draw on brine but also require supplementary fresh water for reagents and product finishing in both evaporation ponds and DLE, with DLE sometimes needing additional fresh water for equipment washing and cooling.

Both deposit types operate in arid, high-Andean landscapes that are home to local and Indigenous communities and are characterised by sensitive high-altitude wetlands of global biodiversity significance. Water quantity and quality are therefore the dominant environmental concerns and basin-level water accounting and cumulative-impact governance are essential, yet frequently lacking, at the project-EIA scale (Petavratzi et al., 2022). Within Argentina, the use of chemicals and potential impacts on water resources remains controversial. Since 2007, Law 7,772 in the province of Mendoza prohibits the use of toxic chemicals such as cyanide and sulfuric acid in exploration, exploitation or industrialisation. The law was upheld by the Supreme Court of Mendoza in 2019 and remains a major obstacle for potential copper projects in Mendoza, where there are many known porphyry deposits (Figure 3).

Argentina recognises 39 Indigenous peoples and more than 1500 communities nationally. Salta, Jujuy and Catamarca alone host 509 communities, with a predominance of Kolla (Jujuy and Salta) and Atacama (Salta) groups (Argento et al., 2019). The deployment of Free, Prior and Informed Consent (FPIC) is widely viewed as insufficient (Lunde Seefeldt, 2022), and conflicts over water resources are frequently linked to perceptions of high water use by lithium mining (Díaz Paz et al., 2023).

The three Argentinian provinces highlighted in this report also show marked variation in how mining projects engage with local communities and organisations. Grounds for resistance range from territorial claims and inadequate consultation to environmental concerns (water, biodiversity, flamingos) and reference to specific legal instruments, including the Ley de Glaciares and the Ramsar Convention (Argento and Puente, 2019; Gonzalez and Snyder, 2020). At the same time, mining is recognised as bringing tangible benefits, and community attitudes are nuanced: the tension between pastoralism and mining employment is typically weighed, not reduced to a binary choice, with local access to jobs, improved services and infrastructure all cited as positives (Escosteguy et al., 2024).

3.4 CUMULATIVE IMPACTS OF LITHIUM AND COPPER MINING IN ARGENTINA

This report explores the cumulative impacts arising from the rapid expansion and co-location of lithium and copper projects in Argentina and how they may be more effectively identified, assessed and managed. Focusing on the provinces of Salta, Jujuy and Catamarca (**Error! Reference source not found.** and **Error! Reference source not found.**), the work aims to contribute evidence to inform policy design, regulatory implementation and investor and operator decisions.

In 2015, the International Finance Corporation (IFC) proposed the concept of cumulative impacts as those 'that result from the successive, incremental, and/or combined effects of an action, project, or activity when added to other existing, planned, and/or reasonably anticipated future ones' (González, 2024). Impacts that appear relatively straightforward within an individual study can turn out to be cumulative and complex when the following are also considered or accounted for (adapted from González, 2024):

- other works, activities, projects and surrounding communities
- past, present and future impacts
- when a basin-scale view is adopted
- the response of natural systems when disturbed by joint activities
- external forces, such as climate change, global demands, institutional governance, etc.

Inadequate management and monitoring of cumulative and indirect environmental impacts has been identified as a systemic issue across the Lithium Triangle (Petavratzi et al., 2022; González, 2024). Furthermore, environmental concerns related to the cumulative effects of extraction and the absence of lithium-specific regulation were identified as a key concern in Argentina by Petavratzi et al. (2022). More recent work reinforces these conclusions, finding that the lack of cumulative impact assessment (CIA) is a key barrier to the rapid and responsible scaling of lithium supply from South American brine resources (Halkes et al., 2024b). Assessing and managing cumulative impacts across multiple projects and economic sectors is an emerging central priority, particularly given the increasing clustering of operations (Figure 5).

Despite these risks, environmental regulation operates predominantly at the individual project level, with limited consideration of cumulative effects across projects, basins or economic sectors. Copper and lithium projects are often co-located within the same or overlapping natural (hydrological; ecological, etc.) systems, yet existing regulatory procedures do not adequately capture their combined impacts. While instruments such as strategic environmental and social assessments (SESAs) exist, they have not been widely or effectively implemented in practice. Efforts have been made to incorporate recommendations regarding cumulative impacts through the Red Latinoamericana de Sistemas de Evaluación de Impacto Ambiental (Latin American Network of Environmental Impact Assessment Systems), established in 2021, but there are reportedly gaps in its effective application (González, 2024). As a result, data on cumulative impacts is often incomplete, fragmented or inaccessible, reflecting a lack of coordination among stakeholders and institutions. Assessing cumulative impacts requires coordinated evaluation across multiple projects and large spatial areas over extended time horizons, an approach that is resource intensive and difficult to implement in the absence of appropriate institutional mechanisms. The growing legal and institutional relevance of cumulative impacts is illustrated by a recent court decision in Argentina. In 2021, the Atacameños del Altiplano Indigenous Community challenged lithium project approvals in the River de los Patos–Salar del Hombre Muerto area, arguing they lacked proper cumulative assessment and consultation. The Court of Justice of Catamarca partially upheld the claim in 2024, requiring authorities to conduct a

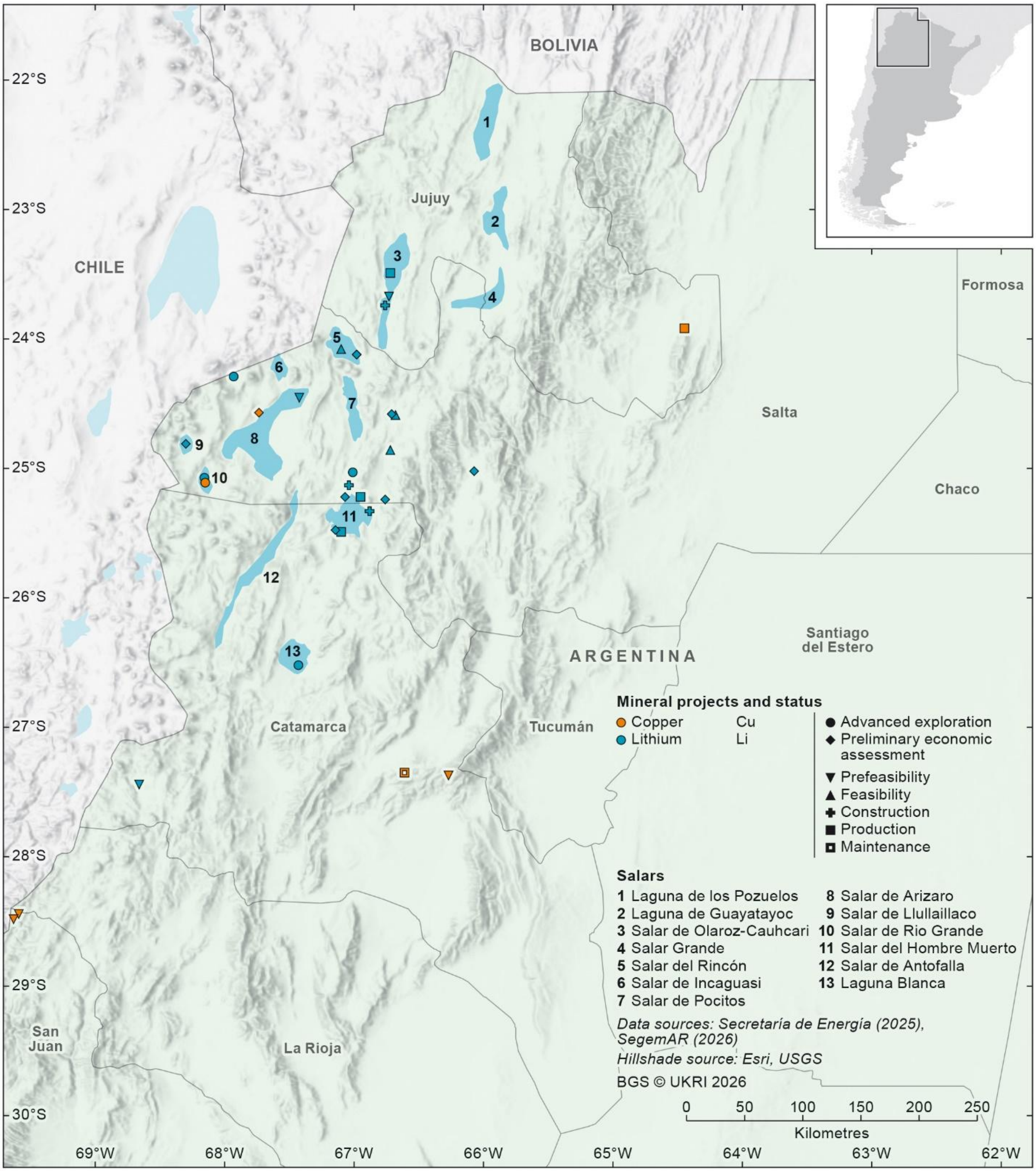

Figure 5 Advanced stage copper and lithium projects in Salta, Jujuy and Catamarca Provinces of Argentina. Adapted from GIS data from Secretaría de Energía (2025) and SEGEMAR (2026). Salar data adapted from Halkes et al. (2024a). BGS © UKRI 2026.

comprehensive cumulative impact study covering environmental and community effects (Blair et al., 2024; González, 2024; OPSAL, 2024). More detail is given in Section 0.

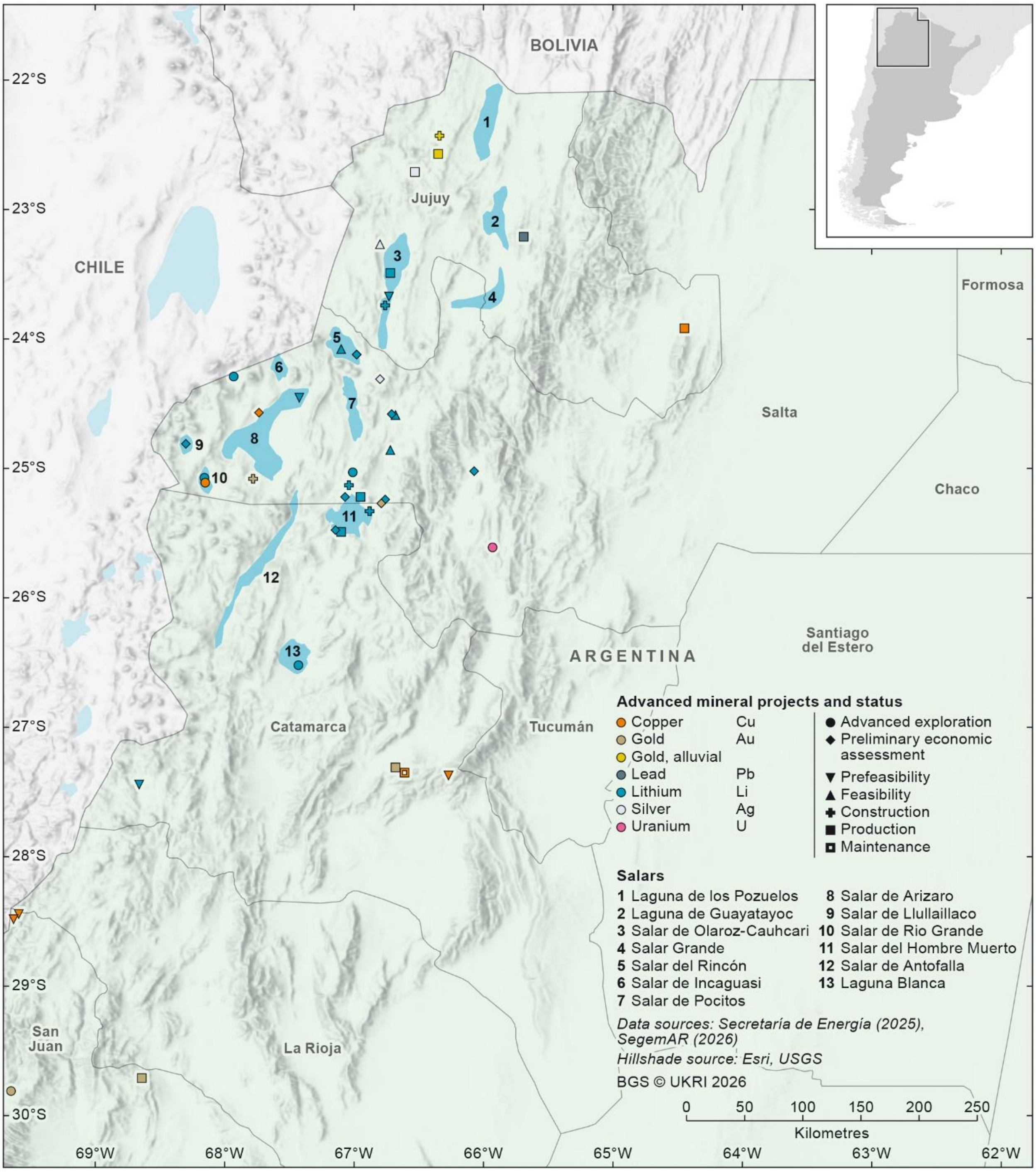

Figure 6 All current advanced mineral projects with status in the Salta, Jujuy and Catamarca Provinces of Argentina. Adapted from GIS data from Secretaría de Energía (2025) and SEGEMAR (2026). Salar data adapted from Halkes et al. (2024a). BGS © UKRI 2026.

4 Scales of Impact – Case Studies

4.1 SALAR DEL RINCÓN

4.1.1 Background

4.1.1.1 LOCATION

Situated in north-western Argentina, (**Figure 5**) Salar del Rincón is seen as a representative salar for lithium brine extraction studies. It is physically close to the Salar de Atacama (Chile), and shares some of the same characteristics (for example, halite, ignimbrite fields, lagunas), but is situated at a higher elevation, with higher precipitation and lower evaporation rates. The Rincón basin has an area of about 2775 km^2, with the salar covering 435 km^2 (**Figure 7**).

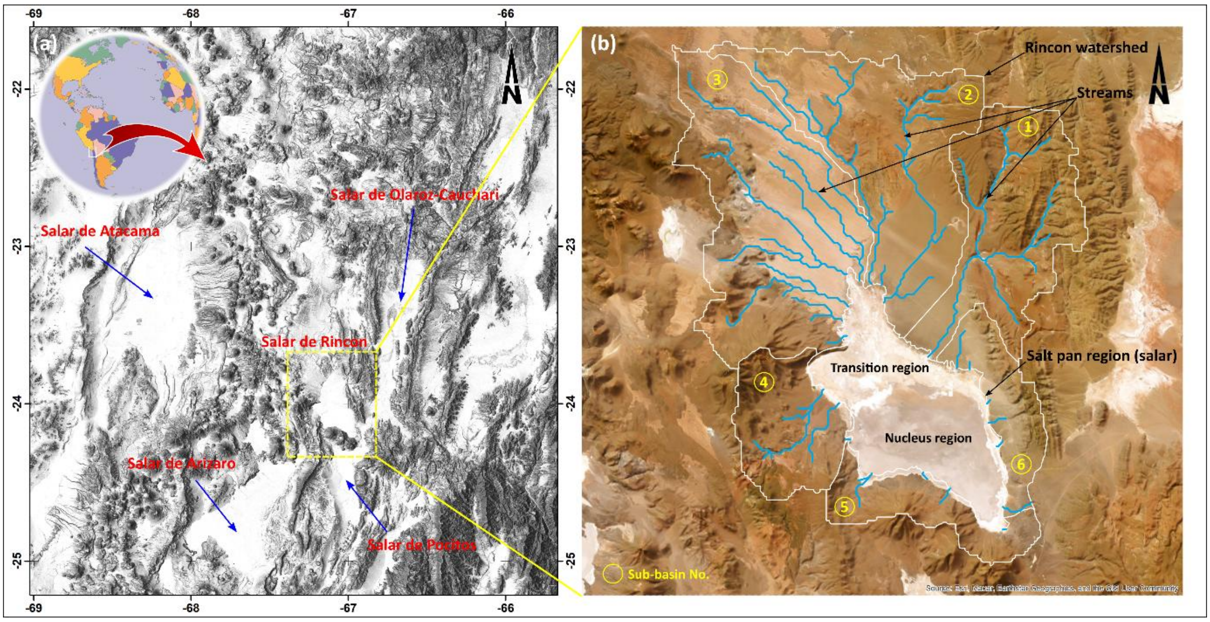

Figure 7 Salar del Rincón. (a) Rincón basin location in Argentina, at the border edge with Chile. (b) The salar is in the southern part of the basin, collecting inflows from six main sub-basins. The salar has two parts: the nucleus region, which contains high-concentration salt water or lithium-rich brine, and the transition (or margin) region where fresh and brine water mix. The northern sub-basins [1, 2, 3] are the main source of salar recharge. BGS © UKRI 2026

4.1.1.2 TOPOGRAPHIC SETTING AND CLIMATE

The ground level in the Rincón basin ranges from 3722 masl at the salar to a maximum of approximately 4590 masl at the northern edge. The basin is surrounded by volcanic mountains to the north and north-west, reaching 5200 masl, and is bordered by several other salars (Figure 8; Farr et al., 2007):

- Salar de Atacama: 2304 masl, to the north-west
- Salar de Arizaro: 3470 masl, to the south-west
- Olaroz-Cauchari: 3900 masl, to the north-east
- Pocitos: 3665 masl, to the south

Beyond elevation, rainfall and evaporation also vary across the basin, broadly following the same spatial patterns as elevation (Figure 8). Mean annual rainfall and potential evapotranspiration range from 22 mm at the western side to over 3500 mm in the south-east for rainfall, and from approximately 1295 mm in parts of the south-east to 2100 mm in the west for PET. These patterns mirror the terrain: higher mountain areas receive less rainfall than lower-lying inland areas to the east and north-east, while western lowland areas towards the coast record the lowest rainfall rates.

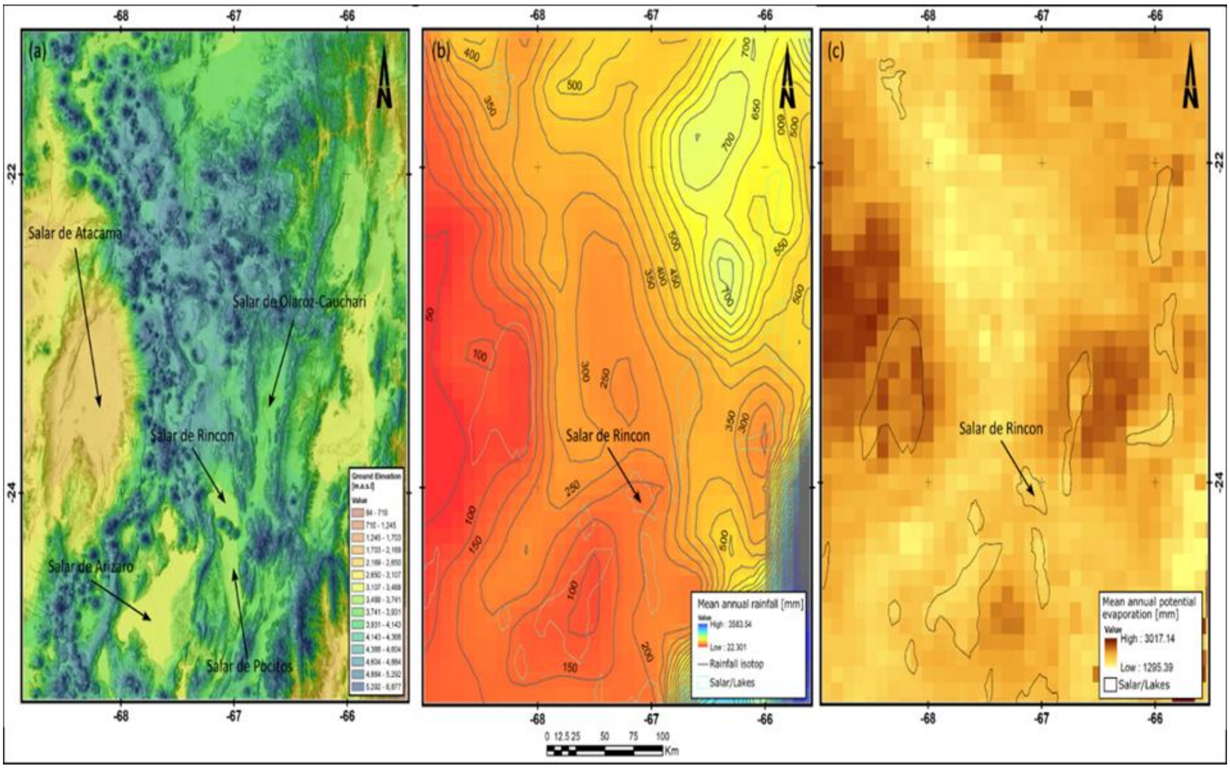

Figure 8 Illustration of ground and weather pattern distribution at Salar del Rincón region. (a) Ground elevation above sea level in metres. Derived from 30 m digital elevation model (DEM) of Shuttle Radar Topography Mission (SRTM) from Farr et al. (2007). (b) and (c) Mean of annual rainfall (mm) and potential evaporation (mm) inside and around the Rincón basin. Derived from ERA5-Land hourly developed by Copernicus Climate Change Service (C3S) at ECMWF (Muñoz-Sabater et al., 2021), respectively. BGS © UKRI 2026.

4.1.1.3 Site visit

BGS staff visited Rio Tinto's Salar del Rincón operation on Friday 3 October 2025 (**Figure 9**). The visit included the pilot DLE plant that produces battery-grade lithium carbonate. It also included a tour of the core store and a visit to a pump test taking place on the alluvial fan. Discussions were held with Rio Tinto staff, who answered questions openly and willingly. The challenges section (Section **Error! Reference source not found.**) is based on a combination of observations made during this visit and background information.

The visit allowed BGS staff to understand Rio Tinto's overall plans for production, starting with a pilot plant (Section **Error! Reference source not found.**). BGS project staff were shown the product, namely battery-grade lithium carbonate, which is transported off site in one-tonne bags. Rio Tinto staff described plans for water supply from the surrounding alluvial fans, along with the development of abstraction boreholes for brine supply. Re-injection is not currently undertaken, with infiltration ponds being the primary discharge method. A tour of the DLE pilot plant demonstrated the chemical and energy needs for production. Alongside the processing plant and associated technical infrastructure, the project footprint consists of an airfield, staff accommodation, offices and other ancillary infrastructure.

Figure 9 Locations visited during the Rincón site visit (clockwise from top left): core laid out in the core store; pumping test taking place on the alluvial fan; one tonne bags of lithium carbonate awaiting shipping; part of the DLE processing plant and site operation buildings. BGS © UKRI 2026.

4.1.2 History of development

4.1.2.1 Rio Tinto operations

Commercial development began when Rio Tinto acquired the Rincón Lithium Project in 2022 from Rincón Mining. Rio Tinto has since advanced the project into a fully integrated brine extraction and processing operation, using DLE technology designed to reduce brine use and improve efficiency and consistency of lithium carbonate production. The company achieved initial lithium production at its 3000 tonnes per annum (tpa) starter plant in November 2024, 32 months after acquisition, and announced plans in December 2024 for a US$2.5 billion expansion targeting a total capacity of 60 000 tpa of battery-grade lithium carbonate (Rio Tinto, 2026). The project consists of a production wellfield, brine distribution infrastructure, waste facilities and processing plant(s). Construction of the large-scale expansion plant began in mid-2025 with full production targeted from 2028 after a three-year ramp-up (Rio Tinto, 2026).

Rio Tinto is also seeking substantial international financing. The IFC has been evaluating a loan facility to support the construction and operation of the Rincón project, with assessments conducted throughout 2025. The IFC review covers environmental, social and technical aspects (Panorama Minero, 2025).

The project qualifies under RIGI, making it one of the country's most significant mining investments. Rio Tinto estimates overall capital expenditure of US$2.5 billion over five years.

4.1.2.2 Other operators and adjacent projects

The Salar del Rincón hosts more than one operator, with adjacent tenements partially overlapping or bordering Rio Tinto's holdings.

Argosy Minerals

Argosy Minerals operates a demonstration-scale lithium carbonate facility on the salar. Although smaller than Rio Tinto's operation, Argosy's work represents an early proof-of-concept for lithium extraction from salar brines and demonstrates the basin's commercial viability (Argentina Lithium, 2026).

Argentina Lithium & Energy Corp. (Rincón West Project)

Argentina Lithium & Energy Corp. controls more than 37 km^2 on the western side of the salar. The company has delineated resources on its 'West Block' and is advancing toward a preliminary economic assessment. Their holdings directly adjoin Rio Tinto's claims on the eastern, western and northern sides, making them geographically interlocking but independently operated projects. The hydrogeological system from which they are planning to abstract is likely to be continuous within the broader salar aquifer, an important subsurface relationship but not an operational integration (Argentina Lithium, 2026).

Regional multi-salar context

Although not strictly an operator within Salar del Rincón, initiatives by Power Minerals and Summit Explore Corp to develop a 'multi-salar solution' (Hidayat, 2026) illustrate how Rincón fits into a broader development model across the region.

4.1.3 Main challenges

Although this section draws on the Rincón case study for specific examples, the challenges outlined here are characteristic of salar-hosted lithium projects more broadly. The discussion, therefore, moves beyond Rincón itself to highlight the wider technical and ESG issues that typically arise across similar operations, using Rincón as an illustrative example where appropriate.

4.1.3.1 Salar understanding including environmental impacts

For most salar-based operations, there are a number of considerations that need to be taken into account to minimise environmental impacts. Among the most important is the collection of baseline data, ensuring sufficient high-quality, pre-development data exists and is fit for purpose — for example, enabling any trace chemical that may be released during the operation to be measured against an established environmental baseline. Leading on from this, it is important that any data collected is made available accessibly, with transparency about the methods of data collection and its distribution. This is particularly important when it comes to community engagement in environmental practices. Finally, it is necessary to understand where ecologically sensitive areas are and the potential impact of operations, particularly groundwater abstraction, on biodiversity.

The operation at Rincón is developing two wellfields: one for brine extraction and the other for the water supply for general operations and the DLE processing plant. This twin wellfield approach may generate greater environmental pressure due to the greater number of wells operated over a larger area and, by extension, the greater volume of water abstracted. This situation places more emphasis on developing a robust understanding of the groundwater system to ensure any potential impact is properly understood and, if necessary, mitigated. Given the significant development on the salar itself, the impacts of support infrastructure and operations need to be quantified. For example, uncontrolled disposal of food waste can encourage animals that prey on flamingos, such as foxes (Marconi et al., 2022). The operations appear to have a significant land footprint even with the use of DLE, due to the associated wellfield. While not a 'blanket coverage' like evaporation ponds, the area of the salar that has human impact is significant.

4.1.3.2 Infrastructure

The basic needs for any mine site are energy, materials and chemicals to be brought in, and the mined product transported out. For a lithium brine operation, the main inputs are related to energy to power the site and, in the case of DLE, run the plant, along with supplies and consumables to run the site as a whole. Ideally, power transmission lines can be used to supply electricity to run both the site and the plant. The product, either lithium chloride or, in the case of Rincón, the granulated battery-grade lithium carbonate, is tankered off to be processed, so access to energy, particularly frictionless, i.e. easily accessible, access, is very important.

Increased road traffic for bringing diesel on site or removing the product has led to increased road traffic affecting tourist routes. The sites (and Rincón is no exception) are remote and the road network is not well developed, which further compounds the issue of access. One corollary of the remoteness is the difficulty of monitoring the activities on the salar, for example visits by regulators.

Integrated planning of infrastructure, such as land use by, for example, solar farms is currently limited and there is no assessment of their social and environmental impacts. There are issues with solar farms related to land use and connection to the grid; for example, the construction of transmission lines and their impact on biodiversity, the latter being related to flyways and the likelihood of migrating birds being affected by the transmission towers. All these issues demonstrate the advantage of using shared infrastructure and its viability, particularly related to how it is managed by the operators themselves or the provincial government.

The Rio Tinto operations at Rincón are not just DLE, but a full lithium carbonate production facility. This is effectively a full-scale chemical plant with commensurate energy requirements. Upstream, i.e. from suppliers of energy and chemicals, and embodied impacts of production sites must be considered, as they are often not accounted for or considered compared to ‘operational impacts’. This has implications for land use, given the size and complexity of operation: while there is a reduction in land use through use of DLE rather than evaporation ponds, the site is still large and takes up a significant area of the salar. Given that the ratio of evaporation pond size to production is of the order 1 km^2 to 4000 tpa, the ‘saved’ land use is approximately 0.75 km^2. This compares to the current site occupying about 0.2 km^2. However, much of this is support infrastructure such as offices, transport, catering and an airfield, as well as a core store.

Although the Salar del Rincón project is dominated by the Rio Tinto operation, there are other competing lithium project interests or exploration (for example, Argosy; Lithium Argentina) within the Rincón basin and solar farms in proximity. This demonstrates that even a single-operator salar requires consideration as to competing infrastructure demands.

4.1.3.3 Social aspects

Given the complexities and interconnectedness of any salar-brine operation, consideration of the social aspects is highly important. Any mistakes made in considering how the operation interacts with civil society can result in loss of the ‘social licence to operate’ (SLO), putting the sustainability of the operation at risk. In addition, socio-economic initiatives and benefits must be carefully managed to ensure that local communities receive what they perceive as their rightful compensation for having a mine in their locality, which is done through meaningful dialogue, shared design, and ownership.

Local populations often have emotional or spiritual connections to the salar, which have to be taken into account with any interactions. Often, an implicit understanding of the local environment is developed by Indigenous peoples and participatory approaches to developing a shared understanding can bring benefits. However, participatory approaches have to be undertaken in the correct spirit, otherwise they may be viewed as superficial or not genuinely collaborative.

The altitude at which operations occur at Rincón (approx. 3700 masl) make it a demanding environment for humans to work in, particularly if they are unused to living and working at altitude — in other words, not local to the area. As a result, operators need to take extra care with employee health through appropriate acclimatisation, monitoring and adapted shift patterns to ensure safe and sustainable working conditions

Finally, given the extreme conditions and the fragility of the environment, any unforeseen or unpredictable impacts, either long-term or short-term, have to be dealt with appropriately to avoid exacerbating social unrest.

4.1.3.4 Governance

The provincial governments are responsible for regulating mines within their territories, although they may lack the capacity to comprehensively assess materials and requests from operators in some instances. Other considerations include non-transparent interactions and how they are dealt by the authorities. Given the isolated nature of the region and the proximity to national borders, organised crime and smuggling can be a problem.

One of the aspects that requires consideration is the relationship between infrastructure owners and potential users, and how governance structures can facilitate the development of joint infrastructure. This can include state-funded major works, public/private partnerships or collaborative industry funding of shared infrastructure.

4.1.4 Summary

There are a number of challenges highlighted in the Rincón case study:

- emerging environmental impacts due to multiple wellfields and lack of re-injection
- burden shifting due to the needs of the on-salar DLE operation and the complexity of the site operation
- competition of resources, even for a single-operator salar

Balanced against this is a significant opportunity for sharing infrastructure with other mining concerns as well as other activities, such as solar farms or tourism. Specific governance structures are needed to achieve holistic infrastructure development. There is the potential for cumulative benefits based on mining ‘pump priming’ regional economic development, but a multi-party approach needs to determine how this can be realised.

4.2 SALAR DEL HOMBRE MUERTO

4.2.1 Background

The Salar del Hombre Muerto (approx. 3970 to 4000 masl), located on the boundary of Catamarca and Salta provinces (**Figure 5**), covers roughly 600 km² and occupies a closed depression bordered by volcanic and sedimentary highs that isolate its hydrology (Godfrey et al., 2013). The salar evolved from a Pleistocene lake system as regional aridification intensified, leading to the deposition of thick evaporite sequences. These include halite and borate-rich sediments in the eastern basin and predominantly halite-rich evaporites in the western basin. Minerals present in the system include halite, ulexite (hydrous sodium calcium borate), gypsum (hydrous calcium sulfate), anhydrite (anhydrous calcium sulfate), thenardite (anhydrous sodium sulfate), and mirabilite (hydrous sodium sulfate), together with lithium-rich brines containing Na-Li-K-Cs-Rb chlorides (Mindat, 2026).

The Salar del Hombre Muerto brine system is characterised by:

- mature halite-core evaporite geomorphology
- highly concentrated lithium brines in unconfined aquifers
- distinct hydrostratigraphy between the western and eastern sub-basins
- strong evaporation potential due to extreme aridity, but with a defined ‘rainy season’ where evaporation is lower

Hydrologically, the salar is sustained mainly by the Río de los Patos, draining from the Galán volcanic complex, and minor inputs from the Río Trapiche and springs (Marconi et al., 2022). These inflows maintain localised perennial lagoons within an arid environment characterised by significant evaporation (Al-Jawad et al., 2024).

Today, the basin is globally significant for its high-grade lithium brines, making it one of the most economically important salars within the Lithium Triangle (Godfrey et al., 2013). However, given the scale and longevity of its exploitation, there are limited publications in the peer-reviewed literature, especially when compared to the Salar de Atacama (Chile) or even Salar de Uyuni (Bolivia).

4.2.2 History of development

The region's brines were systematically investigated between 1990 and 1995, which involved drilling and brine chemistry assessment that confirmed sufficient recoverable reserves within 40 to 700 m depth. The investigation established the economic possibility of long-term extraction of potassium and lithium in combination (Lithium South, 2023).

4.2.2.1 Early commercial development (1990s to 1998)

Following exploration success, industrial development accelerated in the mid-1990s under FMC Corporation, a US chemical producer and the first company to commercialise lithium brine extraction in Argentina. FMC constructed evaporation ponds and chemical processing facilities at the Fénix site and a separate lithium chloride plant in General Güemes, Salta. Full commercial production began in 1998, marking Salar del Hombre Muerto as Argentina's inaugural lithium brine operation (Lithium South, 2023). The initial flowsheet relied on conventional solar evaporation, selective absorption and chemical precipitation to produce lithium carbonate and lithium chloride.

4.2.2.2 FMC era: consolidation and long-term expansion (1998 to 2019)

From 1998 to 2019, FMC oversaw two decades of uninterrupted production through its wholly owned Argentine subsidiary Minera del Altiplano. The operation matured technologically, integrating improved brine handling, pond optimisation and incremental capacity expansions to support growing international demand, particularly for battery-grade lithium chemicals (Lithium South, 2023).

At the end of this period, Salar del Hombre Muerto was producing tens of thousands of tonnes of lithium carbonate and several thousand tonnes of lithium chloride annually, cementing its status as one of the most significant brine operations globally.

4.2.2.3 Corporate transition: spin-off to Livent Corporation (2019)

A major ownership restructure occurred in March 2019, when FMC separated its lithium division into a standalone, publicly traded entity, Livent Corporation. As part of the spin-off, Livent inherited full ownership and operational control of the Fénix facilities. Minera del Altiplano continued as the operating arm within Argentina (Lithium South, 2023).

Livent's tenure saw major reinvestments targeting efficiency and scale. By 2019, annual output reached approximately 17 000 tpa lithium carbonate and 4000 tpa lithium chloride, with plans for expansions exceeding 40 000 tpa in subsequent years (Lithium South, 2023).

4.2.2.4 Sector consolidation: formation of Arcadium Lithium (2024)

Global consolidation in the lithium industry led to a transformative merger between Livent and Allkem (see Section 4.2.2.6) on 4 January 2024, creating Arcadium Lithium plc. This merged entity absorbed multiple regional assets, including Livent's Fénix operation and Allkem's interests, such as the Sal de Vida project on the eastern Salar del Hombre Muerto basin (PUCARA et al., 2023). This merger unified two of Argentina's largest brine portfolios, aligning production strategies, infrastructure and development programmes across the broader Salar del Hombre Muerto system.

4.2.2.5 Transition to major mining house: acquisition by Rio Tinto (2025)

On March 6, 2025, global mining major Rio Tinto completed its acquisition of Arcadium Lithium, thereby becoming the ultimate owner of the Salar del Hombre Muerto Fénix operation and associated assets. Arcadium's businesses, including Minera del Altiplano, were scheduled to be integrated into Rio Tinto Lithium, the company's emerging battery-materials division (PUCARA et al., 2023). This acquisition continued Rio Tinto's expansion into South American brine resources alongside its purchase of Rincón (see Section 4.1), expanding its global lithium footprint.

4.2.2.6 Parallel and adjacent lithium developments

Salar del Hombre Muerto is host to multiple additional brine prospects and development projects (**Figure 10**). The most notable include Sal de Vida and Hombre Muerto North.

Sal de Vida (eastern basin) was originally developed by Galaxy Resources, which acquired the asset via merger with Lithium One in 2012. Galaxy later merged with Orocobre in 2021 to form Allkem, which subsequently merged into Arcadium Lithium in 2024. The project is aiming for long-term annual production of up to 25 000 tpa of battery-grade lithium carbonate (Allkem, 2022).

The Hombre Muerto North project is owned by Lithium South Development Corporation and has undergone extensive hydrogeological, geochemical and resource assessment via NI 43-101 technical evaluations from 2017 to 2024.

4.2.2.7 Modern processing, infrastructure and expansion plans

The Fénix operation is undergoing a staged expansion aimed at increasing the total capacity to 100 000 tpa lithium carbonate by 2030. Upgrades include (PUCARA et al., 2023):

- additional evaporation ponds
- new purification and conversion lines
- integrated development with Sal de Vida infrastructure
- sequential expansion in four phases, with one being ramped up and another currently under construction

These expansions reflect Salar del Hombre Muerto's strategic role in meeting global battery-material demand, particularly as electric vehicle supply chains continue rapid scaling.

4.2.2.8 Summary of development

Salar del Hombre Muerto has evolved from its early geological appraisal in the 1990s to become one of the world's longest-standing and strategically crucial lithium brine operations. Its ownership history, from FMC to Rio Tinto (**Error! Reference source not found.**), reflects broader global trends in the critical minerals sector, particularly consolidation and the entry of major mining houses into the lithium market.

Meanwhile, parallel developments such as Sal de Vida and Hombre Muerto North underscore Salar del Hombre Muerto's ongoing role as a focal point of Argentina's lithium growth strategy. Future production increases and large-scale capacity expansions indicate that Salar del Hombre Muerto will continue to be significant in terms of future global lithium supply.

Table 2 Summary table of the ownership and evolution of projects at Salar del Hombre Muerto (Lithium South, 2023; PUCARA et al., 2023).

Period	Owner	Key events
1990s to 2019	FMC Corporation	Initial exploration; first production (1998); long-term operation via Minera del Altiplano
2019 to 2024	Livent Corporation	Spin-off from FMC; capacity expansions; strong market integration
2024 to 2025	Arcadium Lithium plc	Formation through Livent–Allkem merger; asset consolidation
2025 to present	Rio Tinto	Acquisition of Arcadium; integration into Rio Tinto Lithium

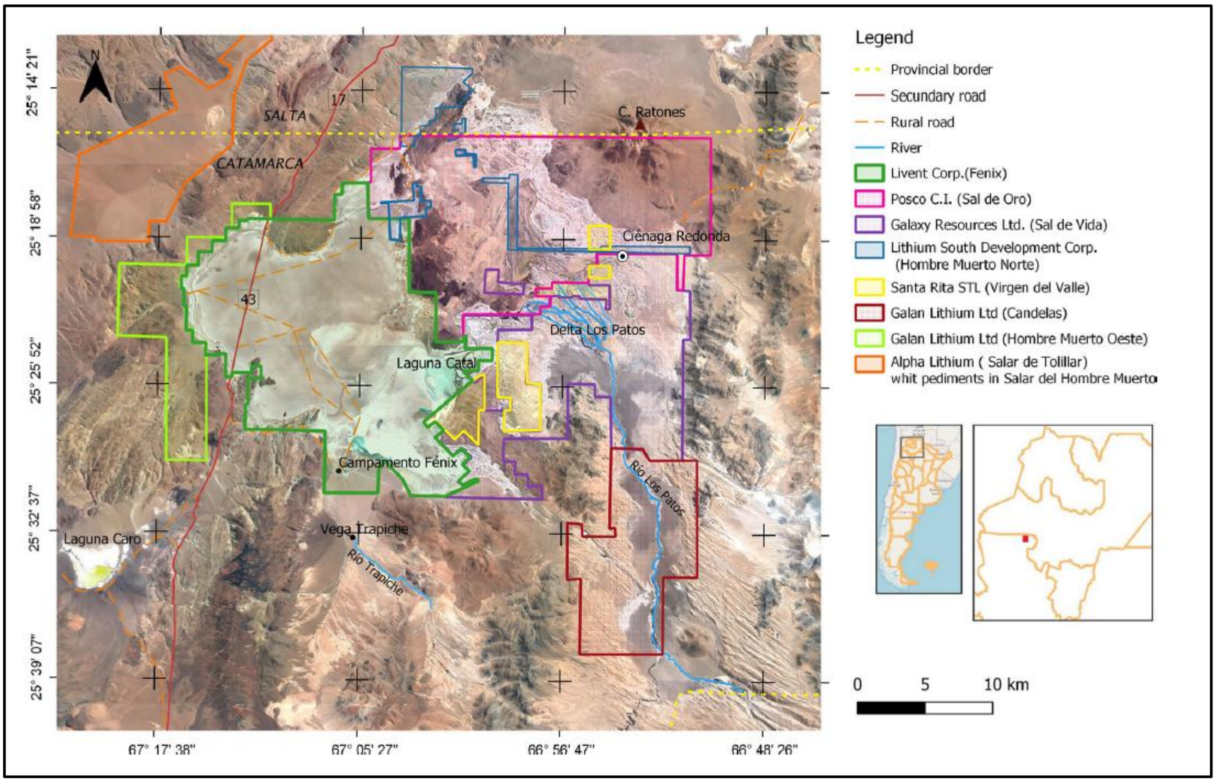

Figure 10 Location of main mineral rights in Salar del Hombre Muerto as of 2021. While now outdated, it is indicative of the overlapping and adjacent nature of mineral rights holdings. Reproduced from Marconi et al. (2022).

4.2.3 Governance Frameworks

Lithium brine extraction at Salar del Hombre Muerto is governed by a layered framework that combines (EJ Atlas, 2024):

- national 'minimum standards'
- provincial control over mineral resources
- inter-provincial coordination
- judicial oversight
- voluntary industry standards

4.2.3.1 Role of the provincial governments

Catamarca's Ministry of Mining and Salta's Secretariat of Mining and Energy administer permits, monitor compliance and approve or condition environmental impact reports for Salar del Hombre Muerto projects. Catamarca's Ministry of Mining functions as the mining authority, with units for mining police, cadastre and environmental control, and has created mechanisms such as mining control centres and transparency portals (including citizen participation and a 'Fideicomiso Minero' trust vehicle). Because Salar del Hombre Muerto crosses the Catamarca–Salta line (**Figure 5**), the provinces established cooperation for projects that span both jurisdictions. This is formalised most visibly around POSCO's Sal de Oro, where the two provinces jointly analysed EIA documentation and have conducted joint technical inspections in the shared cooperation zone. Salta's counterpart agencies coordinate permitting and field inspections.

4.2.3.2 Cumulative impact assessment

In 2021, the Atacameños del Altiplano Indigenous Community filed an environmental protection action before the Court of Justice of Catamarca, seeking the annulment of provincial decrees and ministerial resolutions authorising lithium mining projects in the River de los Patos–Salar del Hombre Muerto area. The community argued that these authorisations were granted without adequate cumulative environmental assessment or proper consultation. This centred around the Fénix Project Expansion and the Sal de Vida Project, as well as other lithium developments in the basin.

The court partially upheld the claim in 2024, ordering the Ministry of Mining and the Ministry of Water, Energy and Environment to undertake a comprehensive and cumulative environmental impact study assessing the combined effects of lithium mining on the river system, landscape, biodiversity, climate and the living conditions and rights of the affected communities. Although the ruling did not suspend existing operations or revoke permits, it required authorities to refrain from granting new permits or environmental approvals in the area until the study is completed (Blair et al., 2024; González, 2024; OPSAL, 2024).

4.2.3.3 Operators and standards

Salar del Hombre Muerto hosts multiple projects:

- Arcadium Lithium's long-running Fénix operation, audited against the Initiative for Responsible Mining Assurance (IRMA) Standard in 2025 (IRMA, 2025)
- POSCO's Sal de Oro (subject to joint Catamarca–Salta oversight) (Salta Gobierno, 2025)
- Galan Lithium's Hombre Muerto West (with provincial phase-1/phase-2 permits) (Galan Lithium, 2025)

While permitting is provincial, voluntary ESG schemes such as IRMA add soft-law accountability to the governance mix.

4.2.4 Main challenges

The main challenge for the environment is the number of operators and the additive nature or juxtaposition of impacts. Put simply, there are significant demands on the natural environment in one salar. In addition, groundwater abstraction does not correlate with political or claim boundaries, so any brine abstraction from different operators can have a multiplication factor in terms of environmental impact. The rivers feeding the salar, Río Trapiche and Río de los Patos, appear to be impacted from both surface- and groundwater abstraction in general (Escosteguy et al., 2024). There has also been concern expressed over the impact on flamingos, particularly in relation to wetlands, and detrimental effects on migratory and breeding habitats (Marconi et al., 2022).

There is significant infrastructure development at the salar simply due to the scale of operations and the length of time that production has been occurring. The remoteness of the site requires significant resources for basic services to operate. This is partly supported by regular flights and, during the COVID-19 pandemic, these flights become an important lifeline for the local community, ensuring supplies were maintained.

This role of the mine supporting the local community is also reflected in the differing and potentially polarised views of the local community towards it (Marconi et al., 2022). The mine's presence is seen as an advantage in terms of jobs and infrastructure; however, there has been growing unrest related to environmental issues (Escosteguy et al., 2024). In response to this, the Provincial Government of Catamarca instituted a requirement that all mining projects needed to undertake a participatory process, which has resulted in 'stakeholder overload' with a significant and often overwhelming number of meetings convened by the operators that local communities can attend.

As described in Section 4.2.3.1, the governance challenges are many and varied. It is a complicated situation, representing almost a national transboundary issue. There are multiple lithium operators that have to interact with cross-province governance, along with a shared cooperation region. The latter adds to the complexity with two provincial governments involved, but does appear to work. However, there is no structured way of applying appropriate ESG standards to the situation. Another consideration is the power imbalance between operators; for example, multinationals such as Rio Tinto compared to less well-resourced operators. This imbalance can have implications for permitting and the less well-resourced operators struggling to provide such comprehensive documentation as the major corporations do.

4.2.5 Summary

There is a complexity of governance responsibilities with competing national and local jurisdictions, with the federal government and two provincial governments (Salta and Catamarca) and their interaction in the cooperation area. Extraction of brine in the salar is undertaken by multiple operators with competing demands on the brine and water resources, notwithstanding the availability of infrastructure in a remote area. There are limited means to address these competing demands, although the recent court ruling in Catamarca recognises the need to address cumulative impacts. A rising level of conflict is associated with lithium brine mining, tempered by the service provided by the mine sites themselves. Current ESG frameworks do not cover this complexity in terms of holistic approaches.

Production at Salar del Hombre Muerto has been ongoing for nearly 30 years and there is less attention paid to the operations than, for example, Atacama, possibly due to its isolation. Nonetheless, Salar del Hombre Muerto can be seen as a success story in terms of longevity of production. The next step could be a more systematic approach in terms of benefits to the area.

4.3 SALAR DE ARIZARO

4.3.1 Background

4.3.1.1 Location

The Salar de Arizaro basin spans more than 6736 km^2 (Al-Jawad et al., 2024) and is located in the province of Salta, approximately 200 km to the west of the city of Salta and close to the Chilean border (**Figure 6**). The salt pan covers approximately 2133 km^2, with an average elevation of 3474 masl, and is bounded by the Archibarca and Antofalla ranges and the volcanic peaks at the Argentina/Chile border (Steinmetz et al., 2020; Al-Jawad et al., 2024).

4.3.1.2 Geology

The Salar de Arizaro is the largest basin in the Argentinian Altiplano–Puna Plateau, at the southern end of the ‘Central Volcanic Zone’ of the central Andes (Boyd et al., 2009). The basin contains approximately 5 km of Eocene to Pliocene-aged (56 to 2.4 Ma) sedimentary strata, including a large thickness of river and lake sedimentary deposits of Miocene age (23 to 5.3 Ma). The Arizaro basin overlays the thinnest area of crust within the Puna Plateau and hosts three known types of mineral deposits: copper, lithium and gold. Copper and gold are associated with porphyry intrusions on the margins. The basin also hosts the largest salt pan of the Argentinian Puna plateau and is considered to be highly prospective for lithium brine extraction, partly due to the size of the salar (Steinmetz et al., 2020).

4.3.2 Development history

4.3.2.1 Copper

The Taca Taca copper-gold-molybdenum porphyry deposit was first discovered in the late 1960s and is 100 per cent owned by First Quantum Minerals (FQM) through their local Argentinian subsidiary Corriente Argentina S.A. The deposit is located at approximately 3500 masl and is hosted in the southern half of a 50 km-long volcanic range that forms the Sierra de Taca Taca mountains.

The mineralisation is hosted in hydrothermally altered rocks in distinct zones several kilometres wide. Copper mineralisation is hosted in both supergene (chalcocite) and hypogene (chalcopyrite) zones as disseminated sulfides, fractures, veinlets or in quartz-veining. Mineralisation remains open at depth and appears to extend beyond the currently explored deposit periphery (FQM, 2026).

The project is at the permitting stage. In February 2026, FQM released a revised NI 43-101 technical report with a revised mineral reserve estimate of 1990 Mt at a copper grade of 0.42 per cent and an initial mine life of 35 years (FQM, 2026). Initial processing capacity is estimated at 40 million tonnes per annum (Mtpa), expanding to 60 Mtpa in the fifth year of operation. Estimated copper production is 291 000 tpa for the first ten years (peak production 323 000 tpa) and subsequent annual production is estimated at 209 000 tpa. Ore will be mined and processed using conventional, large-scale, bulk open-pit mining and flotation, plus a tailings storage facility (TSF). The copper and molybdenum concentrates will be separated and dispatched to off-site smelters (FGM, 2026).

Adjacent to the Taca Taca property, FQM has a 50 per cent interest in the Francisco-I and II joint venture copper concessions with Cascadero Minerals Corporation. In 2021, the previous NI 43-101 technical report for Taca Taca stated that a small, north-west segment of the pit crossed onto this concession and a small area of the proposed TSF was covered by other concessions held by parties for lithium exploration. FQM stated that 'the affected area is considered small enough for non-protracted agreements with those parties' (FQM, 2021). No mention of other mineral projects in the Salar de Arizaro are made in the 2026 revised NI 43-101 report.

4.3.2.2 LITHIUM

Multiple lithium projects are being developed in the Arizaro Basin. Lithium Chile holds the Arizaro project with concessions in the central and south sectors of the salar. The Lithium Chile project is the most advanced lithium project in the basin, currently undergoing feasibility studies (Lithium Chile, 2024). There are four other advanced exploration stage lithium projects (Lithium Chile, 2024):

- Salar de Arizaro project in the western and eastern sectors (Lithium X Energy Corporation)
- Arizaro East in the north-east sector (Noram Lithium Corporation)
- Arizaro project (separate to the Lithium Chile concessions) in the southern sector of the salar (Litica Resources)
- Doncella Lithium project in the western and southern sectors (Hanacolla)

In December 2025, Lithium Chile entered into a definitive agreement to sell 80 per cent of the Arizaro project to China Union Holdings Ltd (The Newswire, 2025).

The Salar de Arizaro was selected as a case study due to multiple lithium projects operating alongside a major advanced-status copper project (Figure 5). This report will use the Lithium Chile Arizaro project for comparison, as it is the only lithium project in the Salar de Arizaro with detailed project information published in an NI 43-101 technical report (Lithium Chile, 2024).

The exploration target for Lithium Chile has a surface expression of 233 m^3 (Lithium Chile, 2024). Production capacity over an estimated 20-year mine life is estimated at 25 000 tpa of battery-grade LCE from DLE and a probable mineral reserve of 490 000 tonnes LCE.

Relative to the Lithium Chile concessions in the centre of the basin:

- the Salar de Arizaro project (Lithium X Energy Corporation) is 26.7 km to the south-west
- the Arizaro East project (Noram Lithium Corporation) is 8.6 km to the east
- the Litica Resources Arizaro project is 18.2 km to the south-west
- some Doncella Lithium concessions are within a few kilometres (at most)

Relative to the Taca Taca concessions:

- Lithium Chile's Arizaro concessions are less than 10 km to the east, with other concessions approximately 40 km to the south
- Salar de Arizaro project (Lithium X Energy Corporation) concessions are within a few kilometres east to south-east and up to approximately 45 km to the south-west
- Arizaro East concessions (Noram Lithium Corporation) are approximately 20 km to the east
- Doncella Lithium project concessions are between approximately 10 and 50 km to the east, south and south-west
- Litica Resources' Arizaro project is at least 18.2 km south-west

4.3.3 Infrastructure

The Salar de Arizaro is considered to have access to excellent infrastructure compared to much of the high Puna Plateau area and is traversed by a paved highway and gravel roads, some of which have been upgraded by the Argentine government to allow heavy road haulage (FQM, 2026). The salar is also crossed by the non-electrified, metre-gauge Salta–Antofagasta railway (C-14 branch) linking Salta to Chile through high-altitude, mountainous terrain near the town of Tolar Grande. This may allow direct access to existing infrastructure for concentrate export to the Chilean coastal ports in the Antofagasta region, subject to negotiation with owners of each section of the railway corridor. A current major use of the railway is the import of reagents, such as carbonate and lime, from the Chilean ports to the lithium mining companies operating in Salta. The closest electrical power infrastructure is approximately 123 km (from Taca Taca) to the north-east (FQM, 2026).

4.3.4 Main challenges

4.3.4.1 Water supply

Both FQM and Lithium Chile state an intention to use the Chascha Sur sub-basin in the southern part of the Salar de Arizaro for at least partial fulfilment of the required supplies of fresh water for exploration and production (Lithium Chile, 2024; FQM, 2026).

FQM states that local and regional wellfields will be developed to supply a combination of fresh water and brine. The processing stages of milling and rougher flotation will require fresh or brackish water sourced from regional boreholes 30 and 50 km away. Run-off from the tailings thickening and sediment collection ponds will be recycled back to the process plant, subject to engineering analysis. The required freshwater input, solely for initial processing requirements, is 1965 cubic metres per hour (m^3/hr). For the entire Taca Taca site, freshwater requirements increase to 2130 m^3/hr (FQM, 2026).

FQM has identified zones of permeable, water-saturated sands and gravels at Valle de Arizaro, Socompa, Valle de Chaschas and Valle de las Burras. The company states that pump testing has shown pumping rates of 40 to 50 litres (L) per second per borehole will be possible in each basin, giving a combined estimated yield in excess of requirements for the first five years of the project (Stage 1: 40 Mtpa extraction). Additional water resources will be required for Stage 2 when extraction ramps up to 60 Mtpa (FQM, 2026).

Brine from adjacent salars is intended for use in the re-pulping of thickened tailings prior to pumping to the TSF. FQM estimates 471 m^3/hr of brine is needed for Stage 1 processing brine and a required input of 600 m^3/hr of brine for the entire Taca Taca site at Stage 1 40 Mtpa extraction. Field investigations indicate potential for up to 1000 m^3 per hour of brine extraction locally from the Salar de Arizaro and the smaller Salar de Taca Taca located off the Salar de Arizaro (FQM, 2026).

The freshwater demands for the Lithium Chile Arizaro project are estimated to be 372 m^3/hr, sourced from the Chascha Sur sub-basin 20 km to the south-east of the planned processing site. This will be sourced using seven to nine pumping wells with a recharge rate of 3.9 to 7.1 cubic hectometers per year (hm^3 yr) (3900000 to 7100000 m^3/a). The requirements for freshwater are 2 769 912 m^3 per annum (Lithium Chile, 2024). Brine requirements have been tested with 2000 L of brine collected from the first production well for metallurgical studies (Lithium Chile, 2024). A raw brine flow of 64 080 m^3 per day will be sourced from up to 500 m depth in the Salar de Arizaro, equating to 19 880 820 m^3 of raw brine per annum. To meet the target of 25 000 tpa of LCE, maximum pumping rates are estimated at 19 L per second from 35 production wells 1 km apart by year 2, with a recharge rate of 524 L per second (Lithium Chile, 2024).

Lithium Chile (2024) state that freshwater exploration to date has included drilling and testing in the southern portion of the basin. Potential freshwater supply is limited to the alluvial cones at the periphery of the Salar de Arizaro, with no public studies available on freshwater exploration and exploitation. Additionally, there are no permanent surface watercourses that feed into the salt flat basin. Currently, the only known source of groundwater in the basin is located in the alluvial fan of the Chascha sub-basin (Lithium Chile, 2024).

It should also be noted that alongside the lithium and copper projects described here, the Lindero porphyry gold mine is also located in the south of the Salar de Arizaro (Figure 6). The 2022 technical report indicated that the Chascha Sur sub-basin would be utilised during operations for freshwater requirements via a series of wells (Fortuna Silver Mines Inc, 2022).

4.3.4.2 Energy requirements

The closest power source to the Salar de Arizaro is the TermoAndes high-voltage powerline, with a transport capacity of 600 megawatts (MW). This is located 100 and 123 km north of the Lithium Chile Arizaro and Taca Taca projects, respectively (Lithium Chile, 2024; FQM, 2026). Major infrastructure projects will be needed to supply any production in the salar (particularly the Taca Taca project), as the closest power source is located in the town of Tolar Grande, which is approximately 40 km to the west and uses diesel generators (Lithium Chile, 2024).

FQM (2026) states that Taca Taca will prioritise the use of renewable (solar) energy where feasible, but has identified a preferred route for a new power line to connect to the TermoAndes infrastructure. Lithium Chile (2024) notes that two photovoltaic plants near the town of Olacapato (approximately 120 km to the north-east) were added in 2021, adding 500 MW to the regional power system. Lithium Chile submitted an environmental impact report for a project power line in 2024 but states that it is currently reviewing alternative possibilities for power generation including liquified natural gas, solar or thermal energy. A natural gas pipeline passes 70 km to the east of the Arizaro project (Lithium Chile, 2024).

4.3.5 Summary

Significant water demands on the Chascha Sur sub-basin in the southern part of the Salar de Arizaro should be anticipated if one or more of the copper and lithium projects begin production. Importantly, FQM states that the water supply is anticipated to be adequate for the first five years of production, but that additional water resources will be required for Stage 2. Therefore, here may be significant potential for competition for the extraction of fresh water or brine if one or more of the multiple lithium projects in the salar also begin production alongside Taca Taca.

Lithium Chile anticipates using DLE for lithium production, which will require a dependable and high-voltage power supply. To move forward on permitting and feasibility studies, both Lithium Chile and FQM are in the process of regulatory impact assessments and, as part of this process, will be outlining power infrastructure intentions. No current literature is available about whether both projects will construct their own required power infrastructure or whether there will be collaboration for common infrastructure. Completion of the ESIA for Taca Taca is anticipated by FQM to be in the first half of 2026, alongside water permit applications and an application to the RIGI scheme (FQM, 2026). In 2024, Lithium Chile anticipated completion of an EIS for the Arizaro project in 2024 or 2025, but has not yet received regulatory approval.

In summary, the situation at Salar de Arizaro illustrates the cumulative impact challenges that arise when multiple extractive projects for different commodities converge on a single basin:

- at least six projects — one copper, one gold and four or more lithium — are at various stages of advancement within the basin, all with significant and partially overlapping demands on the same finite water and brine resources
- neither the Taca Taca nor the Lithium Chile NI 43-101 reports acknowledge neighbouring concessions, despite their shared resource dependencies and proximity
- power infrastructure requirements present a similar challenge, with both projects independently planning connections to the same TermoAndes powerline corridor

As these projects move through permitting and feasibility, the absence of a coordinated framework to assess and manage their competing needs for water, energy and land represents a significant gap — one that requires a coordinated and collaborative approach to identify and manage cumulative impacts. Furthermore, the Salar de Arizaro is indicative of a situation likely to become increasingly commonplace across Argentina as the country looks to scale up lithium and copper production.

5 Discussion

The rapid expansion of lithium and copper mining in Argentina presents both significant development opportunities and a set of complex governance and sustainability challenges. The country now hosts one of the world's densest concentrations of salar-based lithium brine projects.

Although copper production remains limited, geological potential across the Andes is substantial, with numerous projects at various stages of exploration and evaluation. Copper deposits are also expected to yield valuable by-products including tellurium, molybdenum and gold, while a wider portfolio of mining projects reinforces Argentina's growing prominence within global mineral supply chains. Together, these developments position Argentina as a key actor in the energy transition. However, they also raise the fundamental question at the heart of this report: can Argentina harness the benefits of rapid mineral growth while upholding strong ESG performance and effectively managing cumulative impacts across basins, sectors and communities?

5.1 GOVERNANCE

An identified challenge is the fragmented nature of governance. The federal/provincial division of responsibilities generates apparent differences in regulatory capacity, permitting practices and enforcement across provinces. While provinces own mineral resources and issue exploration and production permits, the effects of mining, for example on water abstraction, land-use change and ecological disturbance, extend well beyond provincial boundaries. Existing environmental regulation focuses on individual, project-level EIAs, with limited integration of basin-scale or multi-project assessment tools. Initiatives such as SIACAM and Argentina's adherence to EITI have strengthened transparency in principle, but implementation has been uneven. More significantly, legislative and judicial developments, such as the 2024 court ruling that Salar del Hombre Muerto requires a cumulative environmental assessment before new lithium permits can be issued, highlight the growing importance of CIAs and increasing pressure on authorities to address them systematically. The result is a governance gap: mining is regulated project-by-project even as evidence shows that water, ecosystems and communities experience the consequences of mining cumulatively.

5.2 CUMULATIVE IMPACTS

The concentration of lithium and copper activity within the same geographical corridors creates cumulative impact 'hotspots'. Across Salta, Jujuy and Catamarca, operations increasingly overlap in their demands for water, energy, transport infrastructure and land. The case studies illustrate distinct but interconnected challenges:

- Salar del Rincón: expanding brine and freshwater wellfields by multiple operators creates complex hydrological interactions
- Salar del Hombre Muerto: a dense cluster of projects combined with documented community concerns has already resulted in legal intervention
- Taca Taca–Arizaro: copper-lithium-gold projects share water sources, transport routes and workforce resources

Water rights, Indigenous and civil society challenges, territorial claims and biodiversity protection intersect within basins and project clusters, making the included case studies clear examples of why cumulative impact frameworks are essential. The demand for monitoring cumulative pressures extends to regulators, whose capacity to monitor dispersed operations is already limited. Practical tools, such as SESAs and ESIAs, that extend to basin level, as well as shared monitoring systems and coordinated permitting mechanisms to govern interactions at the regional scale, can provide a positive pathway towards assessing cumulative impacts.

5.3 HYDROLOGY

Hydrological challenges are significant. Lithium brine extraction and porphyry copper mining rely on water sources — brine for lithium operations; fresh or brackish water for copper processing — but both place demands on fragile, high-Andean hydrological systems. These desert environments receive limited rainfall, relying on restricted freshwater inflows, and host sensitive ecosystems such as wetlands, lagunas and high-altitude biodiversity hotspots. Additionally, these areas are culturally and spiritually important to Indigenous communities.

The Glacier Law also has implications for the interaction of operations with the water environment, in this case the cryosphere. Operators such as BHP have expressed concern over these implications and how they may negatively affect the development of copper projects.

With multiple operators drawing from the same groundwater basins, alluvial fans or salars and, in some cases, re-injecting or disposing of water in different parts of the system, the risk of hydrological imbalance increases. The absence of consistent, integrated monitoring frameworks makes it challenging to quantify these interactions or to plan extraction at sustainable levels.

5.4 SOCIAL CONSIDERATIONS

Across all regions, social considerations remain critical. The region is home to more than 500 Indigenous communities whose cultural identities, livelihoods and spiritual traditions are deeply connected to the salars and high-altitude wetlands. Communities report inconsistent implementation of FPIC, contributing to mistrust, litigation and perceptions of exclusion from decision making. The social licence to operate is therefore dependent not just on employment opportunities or revenue channels, but on meaningful, long-term engagement, equitable benefit sharing, transparent data access and careful avoidance of unilateral infrastructure deployment. At the same time, mining presents economic opportunities to communities, including employment, improved services and investment in infrastructure. Effective engagement models must therefore be designed to rebuild trust and to avoid inequalities.

5.5 MINING

The scale of mining associated with copper and lithium in Argentina differs significantly, shaping their respective ESG, infrastructure and economic implications. Lithium production from salars is relatively spatially constrained, with extraction centred on wellfields, evaporation ponds or DLE facilities situated within sensitive high-Andean basins. Although these operations can have significant local impacts, for example on water availability, ecosystems and Indigenous livelihoods, their physical footprint and material throughputs are modest when compared with large-scale porphyry copper mining.

In contrast, copper projects involve:

- large, open pits
- extensive waste-rock storage facilities
- TSFs
- high-volume water and energy requirements
- large workforce
- extensive general infrastructure

As a result, copper mining generates far greater landscape disturbance, long-term waste-management obligations and the potential for downstream environmental risk. Socially, the intensity of land use and infrastructure development associated with copper mining can heighten tensions around territorial rights, consultation processes and cumulative impacts while, economically, these projects offer substantial revenue potential due to their scale. They also require greater regulatory oversight and long-term governance capacity. The contrast in scale therefore influences not only the type and magnitude of impacts, but also the level of institutional coordination, monitoring and community engagement required to manage each commodity responsibly.

5.6 INFRASTRUCTURE

Infrastructure needs are both a constraint and an opportunity. Mining operations occur in remote areas where roads, power lines, water systems and telecommunications networks are limited. Expansion of infrastructure, whether solar farms, transmission lines, wellfields, chemical processing plants or accommodation camps, has the potential to deliver regional socio-economic benefits. However, without coordination across operators and provinces, development may become fragmented, duplicative or environmentally damaging. Shared or open-access infrastructure offers clear advantages for reducing cumulative footprints and costs, but requires governance frameworks capable of planning infrastructure holistically across regions rather than project-by-project.

5.7 ENVIRONMENTAL MONITORING

Reliable environmental monitoring and baseline data remain significant gaps. High-quality pre-development data is not always available and much of the data that does exist is inconsistent, confidential or inaccessible to communities and even regulators. This undermines community trust, limits academic validation and prevents regulators from modelling cumulative impacts credibly.

5.8 TECHNOLOGY

Mining technologies present additional layers of complexity. DLE promises higher lithium recovery and smaller surface footprints, but increases energy and chemical dependency. Solar evaporation ponds have large land footprints and evaporative water losses, but comparatively lower energy intensity. Copper processing has its own challenges, such as high water and energy consumption, large TSFs and risks of acid rock drainage. Different provinces and salars face distinct trade-offs, underscoring the need to integrate technology choice into cumulative assessments and permitting frameworks.

5.9 CUMULATIVE BENEFITS

While much of the policy and academic focus has justifiably concentrated on mitigating cumulative risks, a basin-scale perspective also creates opportunities to generate cumulative benefits through coordination across projects.

- Shared baseline data, integrated monitoring networks and coordinated water-use planning across operations can improve environmental outcomes
- Structured and long-term engagement with Indigenous communities and neighbouring settlements, aligned with local development priorities, can improve access to services, skills and employment
- Shared or sequenced infrastructure, such as roads, power and data corridors, and coordinated logistics can reduce unit costs while minimising the combined footprint of co-located projects
- From a governance perspective, consistent standards, interoperable data systems, transparent regional disclosure and coordinated oversight can streamline permitting and compliance while strengthening accountability

To realise these benefits, cumulative impacts and cumulative benefits must be identified, measured and managed at a range of scales, using appropriate indicators. Framing sustainability in this way helps align incentives among operators, regulators and communities, and provides a foundation for more responsible development of copper and lithium projects in Salta, Jujuy and Catamarca.

6 Conclusions and next steps

6.1 CONCLUSIONS

Argentina is entering a period of accelerated growth in both lithium and copper mining, driven by global demand for critical minerals essential to the energy transition. This expansion is geographically concentrated in the north-western provinces of Salta, Jujuy and Catamarca. While Argentina possesses the geological potential to become a major global supplier, the country's ability to do so responsibly will depend on its capacity to manage cumulative environmental and social impacts, coordinate governance across institutions and provinces, and ensure that development brings broad-based local benefits.

A central finding is that cumulative impacts, not individual project impacts, pose the greatest sustainability risk. Current regulatory frameworks in Argentina primarily evaluate mining projects through project-level EIAs, but these do not adequately consider interactions among multiple operations within the same hydrological or ecological system. High-Andean salars in particular are hydrologically delicate environments with extremely low recharge rates, meaning that the effects of multiple wellfields, even if individually permitted, can combine in ways that accelerate groundwater drawdown, salinity shifts and ecological degradation. In salars such as Salar del Rincón and Salar del Hombre Muerto, brine abstraction, pumping of fresh water and evaporation losses occur simultaneously across different tenements, yet these impacts are typically assessed in isolation. The lack of a basin-scale regulatory framework leads to incomplete understanding of how brine level changes, freshwater inflows and re-injection practices interact over time, and their subsequent effects on natural systems.

One of the primary limiting factors for both lithium and copper development in Argentina is water availability. Lithium brine operations, whether evaporation pond-based or using DLE, require substantial brine abstraction and typically rely on additional sources of fresh water for processing and site operations. Copper mining, by contrast, requires very large volumes of fresh water for milling, flotation and dust suppression, but also proposes utilising basinal brines for some processing operations.

Where lithium and copper projects overlap hydrologically, as in the Salar de Arizaro region, cumulative water demands increase markedly. Several sub-basins identified as potential sources of fresh water are already being targeted by multiple companies across multiple commodities. Such competition raises the risk of aquifer depletion, reduced surface-water flows and ecological impacts in the wetlands and lagunas that are critical for biodiversity. Notably, impacts on wetlands are shown to be more sensitive to freshwater abstraction than brine pumping, meaning that even 'low-impact' lithium projects using DLE can have significant indirect effects.

Another key finding is that governance structures are fragmented and uneven, resulting in gaps in oversight and cumulative-impact management. Under Argentina's federal system, the provincial governments own mineral resources and regulate mining activities, while the federal government sets minimum environmental standards. In practice, provincial authorities differ in technical capacity, transparency and enforcement. The establishment of the lithium roundtable (mesa de litio) enables communication and sharing of best practice between the provinces. This roundtable also allows the discussion of transboundary issues. Provinces such as Salta and Catamarca have made progress in improving information disclosure and establishing institutional mechanisms, yet gaps remain in hydrological oversight, monitoring continuity and the technical review of EIAs. The cross-boundary nature of many salars further complicates governance. Salar del Hombre Muerto, shared by Salta and Catamarca, exemplifies the challenges of aligning regulatory processes, monitoring requirements and consultation obligations across jurisdictions. This complexity contributed to a major 2024 court ruling that requires a basin-wide cumulative environmental assessment to be carried out before additional lithium permits can be issued. The ruling underscores the increasing legal and social scrutiny facing mining projects that lack comprehensive environmental planning.

Linked to governance is the finding that ESG performance and adherence to international standards varies widely across operators. Larger companies (for example, Rio Tinto; FQM) tend to follow more robust environmental and social practices, including independent auditing and alignment with global frameworks such as IRMA or the IFC's Performance Standards, and this is reported to international mining code standards such as NI 43-101 technical reports. Junior operators or smaller domestic firms may have fewer resources or weaker incentives to adopt such standards, resulting in inconsistent quality of environmental baselines, varying degrees of community engagement and uneven approaches to water and waste management. In a cumulative impact context, such variability can exacerbate basin-level risks, as one operator's underperformance or lack of engagement can undermine the sustainability of the entire system.

The study also identifies significant social tensions linked to water use, land rights, participation processes and benefit sharing. Indigenous communities have longstanding cultural, spiritual and livelihood relationships with salars and high-Andean ecosystems. Many local communities express concerns that mining threatens wetlands, grazing lands and traditional livelihoods. Consultation processes, although legally required under ILO Convention 169, are perceived by some communities as insufficient, rushed or overly technical. In some cases, participation requirements have led to 'stakeholder fatigue' without addressing underlying grievances. Local attitudes toward mining are nuanced: many communities value the employment, infrastructure improvements and economic opportunities associated with mining, especially in remote regions with limited state presence. The challenge is ensuring that these benefits are equitably distributed and accompanied by transparent, long-term engagement.

Infrastructure development emerges as both a constraint and an opportunity. Remote locations limit access to energy, transport and monitoring, increasing operational costs and complicating regulatory oversight. At the same time, shared infrastructure such as power lines, roads, renewable energy installations and data-monitoring networks could significantly reduce cumulative impacts while amplifying regional benefits. However, there is currently no coordinated framework for multi-operator infrastructure planning. Without such coordination, parallel developments can lead to duplicating or competing projects and fragmented land use, all of which increase ecological disturbance.

Technological choices also shape cumulative impacts. DLE has potential advantages over evaporation ponds, including higher lithium recovery rates and reduced surface footprint. However, these benefits are not uniform and depend on the specifics of implementation. DLE still requires substantial fresh water, energy and chemical inputs. Re-injection strategies, if used, must be carefully designed to avoid unintended impacts on groundwater flow and salinity gradients. There remains considerable uncertainty about long-term system responses to DLE, reinforcing the need for shared monitoring and transparent hydrogeological modelling.

Finally, opportunities for cumulative benefits have been identified in this study, if coordinated approaches are adopted. Shared baseline datasets, basin-wide hydrological models, collective monitoring networks and consolidated infrastructure plans could significantly reduce environmental risks while improving economic efficiency. There is also an opportunity for Argentina to build national and provincial capacity in hydrogeology, environmental monitoring and community engagement, strengthening the governance architecture needed to support sustainable mineral development.

6.2 NEXT STEPS

The evidence across case studies and discussion points to four cross-cutting priorities:

- basin-scale governance of cumulative impacts
- water as the binding constraint
- coordinated infrastructure
- data, transparency and participation

With these in mind, the following next steps are proposed.

1. Develop a basin-scale cumulative impacts framework and upgrade the ESIA process so cumulative impacts are captured. This could include:
    - setting out the current ESIA requirements and identifying where cumulative impacts are or are not addressed

- defining the regulatory and legislative updates needed to enable basin-scale assessment
- identifying costs and administrative implications, including capacity-building needs for provincial authorities
- mapping implementation pathways and bottlenecks (methodological; institutional; data)
- clarifying how project-level ESIAs interface with SEAs and basin-scale CIAs in practice
- drawing on analogues (for example, Escondida) where off-site socio-hydrological impacts (for example, Salar de Punta Negra; Monturaqui) show how small hydrological changes can have disproportionate effects
- establishing a pilot project in one province to test the framework through a case study, to ensure it functions across multiple spatial and operational scales

2. Build a lithium salar observatory for Argentina, including data gathering and dissemination. This will involve developing both physical infrastructure (research monitoring infrastructure on a salar) as well as a digital platform to make the data available alongside existing data sources:
   - salar observatory: initial development in Argentina but linked to other countries, for example, National Lithium and Salars Institute, Chile (INLiSA)
   - data availability: use portals or a virtual observatory alongside a federated solution, building on existing systems

3. Assessment of DLE and re-injection to understand the environmental footprint of lithium extraction from salar brines:
   - conduct a quantitative assessment of the environmental impacts of DLE combined with brine re-injection, in collaboration with key regional stakeholders, to help establish the true benefits of DLE and re-injection
   - evaluate the physico-chemical effects of brine extraction from the wellfield, such as changes to lagunas, as well as broader environmental factors, including water use and carbon footprint

4. Planned shared infrastructure at corridor scale (power; water; roads; rail; communications):
   - translate the ‘coordinated infrastructure’ priority into practice by planning multi-operator, corridor-level infrastructure to reduce duplicated routes, land disturbance and costs while increasing community benefit
   - identify shared power options (for example, connections to the TermoAndes backbone), road and rail corridors (for example, around Tolar Grande and Arizaro) and water and logistics infrastructure that multiple projects can use
   - apply environmental design standards (biodiversity; cultural heritage; landscape) and benefit-sharing provisions (for example, public access or services, where appropriate)

Abbreviations

ARD	Acid rock drainage
BGS	British Geological Survey
CIA	Cumulative impact assessment
DLE	Direct lithium extraction
DRC	The Democratic Republic of the Congo
EIA	Environmental impact assessment
EITI	Extractive Industries Transparency Initiative
ESG	Environmental, social and governance
ESIA	Environmental and social impact assessment
FPIC	Free, prior and informed consent
FQM	First Quantum Minerals
GIS	Geographical information system
hm^3	Cubic hectometres
IFC	International Finance Corporation
ILO	International Labour Organization
IRMA	Initiative for Responsible Mining Assurance
kt	Kilotonnes
LCE	Lithium carbonate equivalent
m^3/hr	Cubic metres (m^3) per hour
Ma	Million years old
masl	Metres above sea level
Mt	Million tonnes
Mtpa	Million tonnes per annum
MW	Megawatts
NI 43-101	National Instrument 43-101 Standards of Disclosure for Mineral Projects (a regulation that governs how companies can disclose mining-related information in Canada)
SEA	Strategic environmental assessment
SEGEMAR	Servicio Geológico Minero Argentino (Argentine Geological and Mining Service)
SESA	Strategic environmental and social assessment
SIACAM	Sistema de Información Abierta a la Comunidad sobre la Actividad Minera en Argentina (Open Community Information System on Mining Activity in Argentina)
SRTM	Shuttle Radar Topography Mission
tpa	Tonnes per annum
TSF	Tailings storage facility
TSM	Towards Sustainable Mining (initiative)

References

The British Geological Survey holds most of the references listed and copies may be obtained via the library service subject to copyright legislation (contact libuser@bgs.ac.uk for details). The library catalogue is available at https://ukrinerc.on.worldcat.org/discovery.

Al-Jawad, J, Ford, J, Petavratzi, E, and Hughes, A. 2024. Understanding the spatial variation in lithium concentration of high Andean salars using diagnostic factors. *Science of The Total Environment*, Vol. 906, 167647. DOI: https://doi.org/10.1016/j.scitotenv.2023.167647

Allkem. 2022. Sal de Vida project. Salar del Hombre Muerto, Catamarca, Argentina; Project NI 43-101 Technical Report. (Online: Mining Data Online.) Available: https://minedocs.com/22/SaldeVida_TR_03312022.pdf

Argentina Lithium. 2026. Rincon West - about the project. (Online: Argentina Lithium & Energy Corp.) Available: https://argentinalithium.com/projects/rincon-west/

Argento, M, Puente, F, Gamba, M, Kazimierski, M, Romeo, G, Santos, E, Slipak, A, Urrutia, S, and Zicari, J. 2019. Entre el boom del litio y la defensa de la vida. Salares, agua, territorios y comunidades en la región atacameña [in Spanish]. 173–220 in *Litio en Sudamérica: geopolítica, energía y territories*. Fornillo, B (editor). (CLACSO.) Available: https://www.jstor.org/stable/j.ctvtxw25t.9

BBVA Research. 2025. Argentina mining outlook 2025. (Online: Banco Bilbao Vizcaya Argentaria.) Available: https://www.bbvaresearch.com/en/publicaciones/argentina-mining-outlook-2025/

Blair, J J A, Vineyard, N, Mulvaney, D, Cantor, A, Sharbat, A, Berry, K, Bartholomew, E, and Ornelas, A F. 2024. Lithium and water: hydrosocial impacts across the life cycle of energy storage. *WIREs Water*, Vol. 11(6), e1748. DOI: https://doi.org/10.1002/wat2.1748

BNamericas. 2024. Miners urged to take advantage of Chile-Argentina treaty. (Online: BNamericas.com.) Available: https://www.bnamericas.com/en/analysis/miners-urged-to-take-advantage-of-chile-argentina-treaty

Bonelli, C, and Dorador, C. 2021. Endangered *salares*: micro-disasters in northern Chile. *Tapuya: Latin American Science, Technology and Society*, Vol. 4(1), 1968634. DOI: https://doi.org/10.1080/25729861.2021.1968634

Boyd, J, Carrapa, B, Decelles, P G, McNabb, J C, Schoenbohm, L M, Horton, B K. 2009. The structural and tectonic evolution of the Arizaro Basin of the Puna Plateau in NW Argentina. *American Geophysical Union Fall Meeting 2009*, 14–18 December 2009, San Fransisco, USA. Available: https://www.researchgate.net/publication/253384338_The_Structural_and_Tectonic_Evolution_of_the_Arizaro_Basin_of_the_Puna_Plateau_in_NW_Argentina

Canning House. 2024. Mining in Argentina: implications of new investment incentive regime. (Online: Canning House.) Available: https://www.canninghouse.org/canning-insights/mining-in-argentina-implications-of-new-investment-incentive-regime

Concha, G, Broberg, K, Grandér, M, Cardozo, A, Palm, B, and Vahter, M. 2010. High-level exposure to lithium, boron, caesium, and arsenic via drinking water in the Andes of northern Argentina. *Environmental Science & Technology*, Vol. 44(17), 6875–6880. DOI: https://doi.org/10.1021/es1010384

Corenthal, L G, Boutt, D F, Hynek, S A, and Munk, L A. 2016. Regional groundwater flow and accumulation of a massive evaporite deposit at the margin of the Chilean altiplano. *Geophysical Research Letters*, Vol. 43(15), 8017–8025. DOI: https://doi.org/10.1002/2016GL070076

Dentons. 2022. Dentons global mining guide: Argentina. 2022. (Online: Dentons.) Available: https://www.dentons.com/en/insights/newsletters/2022/january/17/dentons-global-mining-guide/dentons-global-mining-guide-2022/argentina

DBT. 2025. Vision 2035: UK critical minerals strategy. (London, UK: HM Government.) Available: https://www.gov.uk/government/publications/uk-critical-minerals-strategy/vision-2035-critical-minerals-strategy

Díaz Paz, W F, Escosteguy, M, Seghezzo, L, Hufty, M, Kruse, E, and Iribarnegaray, M A. 2023. Lithium mining, water resources, and socio-economic issues in northern Argentina: We are not all in the same boat. *Resources Policy*, Vol. 81, 103288. DOI: https://doi.org/10.1016/j.resourpol.2022.103288

Dold, B, and Fontboté, L. 2001. Element cycling and secondary mineralogy in porphyry copper tailings as a function of climate, primary mineralogy, and mineral processing. *Journal of Geochemical Exploration*, Vol. 74(1–3), 3–55. DOI: http://doi.org/10.1016/S0375-6742(01)00174-1

EJ Atlas. 2024. Lithium mining in Salar del Hombre Muerto, Argentina. (Online: Environmental Justice.) Available: https://ejatlas.org/conflict/salar-del-hombre-muerto-litio-argentina

Escosteguy, M, Ortega Insaurralde, C, Díaz Paz, W F, Brannstrom, C, Iribarnegaray, M A, Hufty, M, and Seghezzo, L. 2024. The political ecology of justice outcomes of lithium mining: the case of Salar del Hombre Muerto, Argentina. *The Extractive Industries and Society*, Vol. 18, 101477. DOI: http://doi.org/10.1016/j.exis.2024.101477

EITI. 2022. Argentina. 2022. (Online: Extractive Industries Transparency Initiative.) Available: https://eiti.org/countries/argentina

Farahbakhsh, J, Arshadi, F, Mofidi, Z, Mohseni-Dargah, M, Kök, C, Assefi, M, Soozanipour, A, Zargar, M, Asadnia, M, Boroumand, Y, Presser, V, and Razmjou, A. 2024. Direct lithium extraction: a new paradigm for lithium production and resource utilisation. *Desalination*, Vol. 575, 117249. DOI: https://doi.org/10.1016/j.desal.2023.117249

Farr, T G, Rosen, P A, Caro, E, Crippen, R, Duren, R, Hensley, S, Kobrick, M, Paller, M, Rodriguez, E, Roth, L, Seal, D, Shaffer, S, Shimada, J, Umland, J, Werner, M, Oskin, M, Burbank, D, and Alsdorf, D. 2007. The Shuttle Radar Topography Mission. *Reviews of Geophysics*, Vol. 45(2). DOI: https://doi.org/10.1029/2005RG000183

FQM. 2021. Taca Taca Project Amended and Restated NI 43-101 Technical Report. (Online: First Quantum Minerals.) Available: https://www.first-quantum.com/wp-content/uploads/2025/08/NI-43-101-Technical-Report-Taca-Taca.pdf

FQM. 2026. Taca Taca Project NI 43-101 Technical Report. (Online: First Quantum Minerals.) Available: https://www.first-quantum.com/wp-content/uploads/2026/02/Taca-Taca-Project-Technical-Report-2025-FINAL.pdf

Flexer, V, Baspineiro, C F, and Galli, C I. 2018. Lithium recovery from brines: a vital raw material for green energies with a potential environmental impact in its mining and processing. *Science of The Total Environment*, Vol. 639, 1188–1204. DOI: http://doi.org/10.1016/j.scitotenv.2018.05.223

Fuentealba, D, Flores-Fernández, C, Troncoso, E, and Estay, H. 2023. Technological tendencies for lithium production from salt lake brines: progress and research gaps to move towards more sustainable processes. *Resources Policy*, Vol. 83, 103572. DOI: https://doi.org/10.1016/j.resourpol.2023.103572

Galan Lithium. 2025. Full HMW Phase 2 (21ktpa LCE) Mining Permit Granted. (Online: Mining Data Online.) Available: https://minedocs.com/27/Galan-Lithium-Investor-PR-01062025.pdf

Godfrey, L V, Chan, L-H, Alonso, R N, Lowenstein, T K, Mcdonough, W F, Houston, J, Li, J, Bobst, A, and Jordan, T E. 2013. The role of climate in the accumulation of lithium-rich brine in the central Andes. *Applied Geochemistry*, Vol. 38, 92–102. DOI: https://doi.org/10.1016/j.apgeochem.2013.09.002

González, U. 2024. Cumulative impacts on lithium: guidelines for integration and approach. (Online: BNamericas.com.) Available: https://www.bnamericas.com/en/opinion/cumulative-impacts-on-lithium-guidelines-for-integration-and-approach

González, L I, and Snyder, R. 2023. Modes of extraction in Latin America's Lithium Triangle: explaining negotiated, unnegotiated, and aborted mining projects. *Latin American Politics and Society*, Vol. 65(1), 47–73. DOI: http://doi.org/10.1017/lap.2022.32

Guajardo, I. 2025. Argentina's copper opportunity. (Online: Payne Institute for Public Policy.) Available: https://payneinstitute.mines.edu/argentinas-copper-opportunity/

Gutiérrez, J S, Moore, J N, Donnelly, J P, Dorador, C, Navedo, J G, and Senner, N R. 2022. Climate change and lithium mining influence flamingo abundance in the Lithium Triangle. *Proceedings of the Royal Society B: Biological Sciences*, Vol. 289(1970), 20212388. DOI: https://doi.org/10.1098/rspb.2021.2388

Halkes, R T, Hughes, A, Wall, F, Petavratzi, E, Pell, R, and Lindsay, J J. 2024a. Life cycle assessment and water use impacts of lithium production from salar deposits: challenges and opportunities. *Resources, Conservation and Recycling*, Vol. 207, 107554. DOI: http://doi.org/10.1016/j.resconrec.2024.107554

Halkes, R T, Petavratzi, E, Ford, J, and Hughes, A. 2024b. Lithium brines in South America: a research roadmap to facilitate rapidly and responsibly sourced lithium. *British Geological Survey Open Report* OR/24/029. (Nottingham, UK, British Geological Survey.) Available: https://nora.nerc.ac.uk/id/eprint/539363/

Herrera, C, Custodio, E, Chong, G, Lambán, L J, Riquelme, R, Wilke, H, Jódar, J, Urrutia, J, Urqueta, H, Sarmiento, A, Gamboa, C, and Lictevout, E. 2016. Groundwater flow in a closed basin with a saline shallow lake in a volcanic area: Laguna Tuyajto, northern Chilean altiplano of the Andes. *Science of The Total Environment*, Vol. 541, 303–318. DOI: http://doi.org/10.1016/j.scitotenv.2015.09.060

Hidayat, M. 2026. World first multi-salar lithium project in Argentina. (Online: Discovery Alert.) Available: https://discoveryalert.com.au/lithium-extraction-future-argentina-2026-multi-salar/

Houston, J. 2006. Variability of precipitation in the Atacama Desert: its causes and hydrological impact. *International Journal of Climatology*, Vol. 26(15), 2181–2198. DOI: https://doi.org/10.1002/joc.1359

Idoine, N E, Raycraft, E R, Hobbs, S F, Everett, P, Evans, E J, Mills, A J, Currie, D, Horn, S, and Shaw, R A. 2024. World mineral production 2018-2022. (Nottingham, UK: British Geological Survey.) ISBN 978-0-85272-800-0. Available: https://nora.nerc.ac.uk/id/eprint/537241/

IEA. 2025. Global critical minerals outlook 2025. (Online: IEA.) Available: https://www.iea.org/reports/global-critical-minerals-outlook-2025

ITA. 2023. Argentina — trade agreements. (Online: International Trade Administration.) Available: https://www.trade.gov/country-commercial-guides/argentina-trade-agreements

IRMA. 2025. Fenix lithium mine audit packet. (Online: Initiative for Responsible Mining Assurance.) Available: https://responsiblemining.net/wp-content/uploads/2025/02/Fenix-audit-packet.pdf

Kelly, J C, Wang, M, Dai, Q, and Winjobi, O. 2021. Energy, greenhouse gas, and water life cycle analysis of lithium carbonate and lithium hydroxide monohydrate from brine and ore resources and their use in lithium ion battery cathodes and lithium ion batteries. *Resources, Conservation and Recycling*, Vol. 174, 105762. DOI: https://doi.org/10.1016/j.resconrec.2021.105762

Kinnunen, P H M, and Kaksonen, A H. 2019. Towards circular economy in mining: Opportunities and bottlenecks for tailings valorisation. *Journal of Cleaner Production*, Vol. 228, 153–160. DOI: https://doi.org/10.1016/j.jclepro.2019.04.171

Lithium Chile. 2024. Salar de Arizaro Project NI 43-101 Technical Report and Pre-Feasibility Study. (Online: Lithium Chile.) Available: https://lithiumchile.ca/wp-content/uploads/2024/10/Salar-de-Arizaro-NI-43-101-Technical-Report-and-PFS_FINAL-lith.pdf

Lithium South. 2023. Updated mineral resource estimate — Hombre Muerto North Project NI 43-101 Technical Report. (Online: Lithium South Development Corporation.) Available: https://www.lithiumsouth.com/wp-content/uploads/2023-technical-report-NI43-101.pdf

Lorca, M, Olivera Andrade, M, Escosteguy, M, Köppel, J, Scoville-Simonds, M, and Hufty, M. 2022. Mining indigenous territories: consensus, tensions and ambivalences in the Salar de Atacama. *The Extractive Industries and Society*, Vol. 9, 101047. DOI: https://doi.org/10.1016/j.exis.2022.101047

Lottermoser, B. 2010. Mine Wastes: characterisation, treatment and environmental impacts. Third Edition. (Heidelberg, Germany: Springer Berlin.) DOI: https://doi.org/10.1007/978-3-642-12419-8

Marazuela, M A, Vazquez-Sune, E, Custodio, E, Palma, T, Garcia-Gil, A, and Ayora, C. 2018. 3d mapping, hydrodynamics and modelling of the freshwater-brine mixing zone in salt flats similar to the Salar de Atacama (Chile). *Journal of Hydrology*, Vol. 561, 223–235. DOI: http://doi.org/10.1016/j.jhydrol.2018.04.010

Marazuela, M A, Vázquez-Suñé, E, Ayora, C, García-Gil, A, and Palma, T. 2019. The effect of brine pumping on the natural hydrodynamics of the Salar de Atacama: the damping capacity of salt flats. *Science of The Total Environment*, Vol. 654, 1118–1131. DOI: https://doi.org/10.1016/j.scitotenv.2018.11.196

Marconi, P, Arengo, F, and Clark, A. 2022. The arid Andean plateau waterscapes and the Lithium Triangle: flamingos as flagships for conservation of high-altitude wetlands under pressure from mining development. *Wetlands Ecology and Management*, Vol. 30(4), 827–852. DOI: https://doi.org/10.1007/s11273-022-09872-6

Mindat. 2026. Salar del Hombre Muerto, Argentina. (Online: Hudson Institute of Mineralogy.) Available: https://www.mindat.org/loc-229832.html

MOM Mining. 2026. Proyecto Martin Bronce. (Online: MOM Mining.) Available: https://mommining.com.ar/martin-bronce/

Moran, B J, Boutt, D F, McKnight, S V, Jenckes, J, Munk, L A, Corkran, D, and Kirshen, A. 2022. Relic groundwater and mega drought confound interpretations of water sustainability and lithium extraction in arid lands. *ESS Open Archive*. DOI: https://doi.org/10.1002/essoar.10510758.1

Mudd, G M. 2010. The environmental sustainability of mining in Australia: key mega-trends and looming constraints. *Resources Policy*, Vol. 35(2), 98–115. DOI: https://doi.org/10.1016/j.resourpol.2009.12.001

Mudd, G M, Weng, Z, and Jowitt, S M. 2013. A detailed assessment of global cu resource trends and endowments. *Economic Geology*, Vol. 108, 1163–1183. DOI: https://doi.org/10.2113/econgeo.108.5.1163

Mudd, G, Josso, P, Shaw, R, Luce, A, Singh, N, Horn, S, Bide, T, Currie, D, Elliott, H, Grant, H, Halkes, R, Idoine, N, Mitchell, C, Watkins, I, Price, F, and Petavratzi, E. 2024. UK 2024 criticality assessment. *British Geological Survey Open Report* OR/24/047. (Nottingham, UK: British Geological Survey.) Available: https://nora.nerc.ac.uk/id/eprint/538471/

Munk, L, Hynek, S, Bradley, D C, Boutt, D, Labay, K A, and Jochens, H. 2016. Lithium brines: a global perspective. 339–365 in *Rare Earth and Critical Elements in Ore Deposits* , Vol. 18. Verplanck, P L, and Hitzman, M W (editors). (Society of Economic Geologists.) DOI: https://doi.org/10.5382/Rev.18.14

Munk, L A, Boutt, D F, Moran, B J, McKnight, S V, and Jenckes, J. 2021. Hydrogeologic and geochemical distinctions in freshwater-brine systems of an Andean salar. *Geochemistry, Geophysics, Geosystems*, Vol. 22(3), e2020GC009345. DOI: https://doi.org/10.1029/2020GC009345

Murguía, D I, and Bastida, A E. 2023. Critical and energy transition minerals in Argentina: mineral potential and challenges for strengthening public institutions. *Geological Society, London, Special Publications*, Vol. 526(1), 153–173. DOI: https://doi.org/10.1144/SP526-2022-172

Nicolaci, H, Young, P, Snowdon, N, Rai, A, Chen, T, Zhang, J, Lin, Y, Bailey, E, Shi, R, and Zheng, N. 2023. Direct lithium extraction: a potential game changing technology. (Online: Goldman Sachs.) Available: https://www.goldmansachs.com/pdfs/insights/pages/gs-research/direct-lithium-extraction/report.pdf

OPSAL. 2024. Argentina: precautionary measure filed by Atacameños del altiplano community stops new mining permits in Salar del Hombre Muerto and orders measurement of cumulative impacts. (Online: Observatorio Plurinacional de Salares Andinos.) Available: https://salares.org/argentina-precautionary-measure-filed-by-atacamenos-del-altiplano-community-stops-new-mining-permits-in-salar-del-hombre-muerto-and-orders-measurement-of-cumulative-impacts/

Panorama Minero. 2024. Jujuy Province: two copper and gold projects thrive with local investment. (Online: Panorama Minero.) Available: https://www.panorama-minero.com/en/news/jujuy-province-two-copper-and-gold-projects-thrive-with-local-investment

Panorama Minero. 2025. Rio Tinto seeks financing and targets Rincón production start by late 2027. (Online: Panorama Minero.) Available: https://www.panorama-minero.com/en/news/rio-tinto-seeks-financing-and-targets-rincon-production-start-by-late-2027

Perelló, J, Sillitoe, R H, Rossello, J, Forestier, J, Merino, G, Charchaflie, D. 2023. Geology of porphyry Cu-Au and epithermal Cu-Au-Ag mineralisation at Filo del Sol, Argentina-Chile: extreme telescoping during Andean uplift. *Economic Geology*, Vol. 118, 1261–1290. DOI: https://doi.org/10.5382/econgeo.5029

Petavratzi, E, Sanchez-Lopez, D, Hughes, A, Stacey, J, Ford, J, and Butcher, A. 2022. The impacts of environmental, social and governance (ESG) issues in achieving sustainable lithium supply in the Lithium Triangle. *Mineral Economics*, Vol. 35(3), 673–699. DOI: http://doi.org/10.1007/s13563-022-00332-4

PUCARA, FARN, Fundación Yuchan, and BIC. 2023. Sal de Vida: a risky lithium mining project in Argentina. (Online: OHCHR, UN.) Available: https://www.ohchr.org/sites/default/files/documents/issues/development/wg/cfi-financialinstitutions/submissions-dfi-hrc53-cso-asamblea-pueblos-catamarquenos-en-resistencia-y-autodeterminacion-et-al.pdf

Rio Tinto. 2026. Rincon. (Online: Rio Tinto plc.) Available: https://www.riotinto.com/en/operations/south-america/rincon

Rosen, M R. 1994. The importance of groundwater in playas: a review of playa classifications and the sedimentology and hydrology of playas. In *Paleoclimate and Basin Evolution of Playa Systems*. Rosen, M R (editor). DOI: https://doi.org/10.1130/SPE289-p1

Rossi, C, Bateson, L, Bayaraa, M, Butcher, A, Ford, J, and Hughes, A. 2022. Framework for remote sensing and modelling of lithium-brine deposit formation. *Remote Sensing*, Vol. 14(6), 1383. DOI: http://doi.org/10.3390/rs14061383

Salta Gobierno. 2025. Salta and Catamarca carried out a joint technical inspection in the Sal de Oro project [in Spanish]. (Online: Salta Gobierno.) Available: https://www.salta.gob.ar/prensa/noticias/salta-y-catamarca-llevaron-adelante-una-inspeccion-tecnica-conjunta-en-el-proyecto-sal-de-oro-100079

Schlesinger, M E, Sole, K C, and Davenport, W G. 2011. Extractive Metallurgy of Copper. (Elsevier.) ISBN 978-0-08-096789-9. DOI: https://doi.org/10.1016/C2010-0-64841-3

Secretaría de Energía. 2025. Proyectos mineros (ubicación aproximada) [in Spanish]. (Online: Argentina Data.) Available: https://datos.gob.ar/dataset/energia-proyectos-mineros-ubicacion-aproximada

Secretariat of Mining. 2024. Mining potential in Argentina. 2024. *Ministerio de Economía* (Argentina).

Secretariat of Mining. 2025. Mining potential in Argentina. 2025 *Ministerio de Economía* (Argentina).

SEGEMAR. 2026. Depositos minerales metaliferos 250k. (Buenos Aires, Argentina: Segemar SIGAM.) Available: https://sigam.segemar.gov.ar/geonetwork39/srv/spa/catalog.search#/metadata/edf20fa93001726f635e48a4e10a6065e0ed49b4

Sillitoe, R H. 2010. Porphyry copper systems. *Economic Geology*, Vol. 105(1), 3–41. DOI: https://doi.org/10.2113/gsecongeo.105.1.3

Sillitoe, R H, and Perelló, J. 2005. Andean copper province: tectonomagmatic settings, deposit types, metallogeny, exploration and discovery. In *Economic Geology One Hundredth Anniversary Volume*. Hedenquist, J W, Thompson, J F H, Goldfarb, R J, and Richards, J P (editors). (Society of Economic Geologists.) DOI: https://doi.org/10.5382/AV100.26

Stacey, J R. 2019. Lithium mining in the High Puna of the Andes: an environmental blessing with some dark footprints? (Online: Levin Sources.) Available: https://www.levinsources.com/assets/pages/Lithium-Mining-High-Puna-Andes-Famingo.pdf

Steinmetz, R L L, Salvi, S, Sarchi, C, Santamans, C, Steinmetz, L C L. 2020. Lithium and brine geochemistry of the salars of the southern Puna, Andean Plateau of Argentina. *Economic Geology*, Vol. 115, 1079–1096. DOI: https://doi.org/10.5382/econgeo.4754

Taillant, J D. 2015. Glaciers: the politics of ice. (Online: Oxford University Press.) ISBN 978-0-19-936726-9. DOI: https://doi.org/10.1093/oso/9780199367252.001.0001

The Mining Association of Canada. 2016. Towards sustainable mining. (Online: The Mining Association of Canada.) Available: https://mining.ca/towards-sustainable-mining/

The Newswire 2025. Press release: Lithium Chile executes the formal agreement for the sale of its Argentine Arizaro project. (Online: The Newswire.) Available at https://www.thenewswire.com/press-releases/1AwGFqNNp-lithium-chile-executes-the-formal-agreement-for-the-sale-of-its-argentine-arizaro-project.html

USGS 2026. United States Geological Survey Mineral Commodity Summaries: Copper. Available from: https://pubs.usgs.gov/periodicals/mcs2026/mcs2026-copper.pdf

Vera, M L, Torres, W R, Galli, C I, Chagnes, A, and Flexer, V. 2023. Environmental impact of direct lithium extraction from brines. *Nature Reviews Earth & Environment*, Vol. 4(3), 149–165. DOI: https://doi.org/10.1038/s43017-022-00387-5