

Lithium-rich brines in the Central Andean salars of Argentina, Bolivia, and Chile

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ABSTRACT. The Central Andes of South America are characterized by a succession of ~N-S trending ranges and closed basins occupied by numerous ‘saline lakes’, ‘salt crusts’, and ‘salars’. The term ‘salar’ describes a continental saline deposit composed mainly of a salt crust, brine with dissolved elements of potential economic interest, and a clastic fraction of sedimentary and/or volcanic origin, formed by the evaporation of groundwater in hydrographically closed arid basins. The discovery of lithium-rich brines in the Salar de Atacama (northern Chile) in 1969 initiated the identification of one of the world’s major lithium-rich brine regions. Today, the Central Andes account for a significant portion of the world’s lithium production; for example, in 2025, Chile and Argentina produced 27% of the estimated world’s total of 290,000 tons of lithium. The region became a major producer due to the large size of its deposits and the high quality of its lithium-rich brines. In addition to lithium, the brines contain potassium, boron, and magnesium. Out of the 130 salars known in the Central Andes, this contribution focuses on 43 evaluated deposits with lithium-rich brines reported to date. Reports, evaluations, and exploration surveys provide an updated perspective on the state of knowledge regarding lithium-rich brines in the Central Andes. Recent developments are promising: the identified lithium reserves and resources, together with favorable exploration prospects, position this region as a significant contributor to the global lithium industry.

Keywords: Andes, Central Andes, Salar, Lithium, Brine.

RESUMEN. Salmueras ricas en litio en los salares de los Andes Centrales de Argentina, Bolivia y Chile. Los Andes Centrales de Sudamérica se caracterizan por una sucesión de cadenas cordilleranas de orientación aproximada norte-sur, con cuencas cerradas ocupadas por numerosos lagos salinos, costras salinas y salares. El término salar describe un depósito salino continental compuesto principalmente por una costra de sal, una salmuera con elementos disueltos de potencial interés económico, y una fracción clástica de origen sedimentario y/o volcánico, formado por la evaporación de agua subterránea en cuencas áridas hidrográficamente cerradas. El descubrimiento de salmueras ricas en litio en el salar de Atacama (norte de Chile) en 1969 inició la identificación de una de las mayores regiones continentales del mundo con salmueras ricas en litio. Actualmente, los Andes Centrales aportan una porción significativa de la producción mundial de litio; por ejemplo, en 2025, Chile y Argentina produjeron un 27% del total mundial que alcanzó las 290.000 toneladas de litio. La región destaca a nivel mundial gracias al gran tamaño de sus depósitos y a la alta calidad de sus salmueras ricas en litio. Además de litio, estas salmueras contienen potasio, boro y magnesio. De los 130 salares conocidos en los Andes Centrales, este estudio se centra en 43 depósitos evaluados por su contenido de litio en salmueras. Informes, evaluaciones y trabajos de exploración ofrecen una perspectiva actualizada acerca del estado del conocimiento de las salmueras ricas en litio en los Andes Centrales. Los desarrollos recientes son promisorios: la cantidad identificada de reservas y recursos de litio, en conjunto con varios prospectos favorables de exploración, sitúa a la región como un contribuidor significativo para la industria global del litio.

Palabras clave: Andes, Andes Centrales, Salar, Litio, Salmuera.

1. Introduction

Critical minerals are essential to achieve the green energy transition. Lithium, for example, an element of growing interest in modern technologies, is a key metal for electromobility and energy storage from renewable sources (Lusty *et al.*, 2021; European Commission, 2023; USGS, 2025). Although lithium is widely distributed on Earth, it does not occur in elemental form because of its high reactivity; instead, it is present in a variety of forms, including lithium carbonate (Li_2CO_3), lithium oxide (Li_2O), and lithium hydroxide (LiOH). Lithium (and its compounds) enable clean energy through rechargeable batteries for electronics, electric vehicles, and grid storage, uses that account for ~80% of the global demand (Tankou and Hall, 2026). In addition, due to its natural properties, lithium improves productivity and energy savings in glassmaking processes, and its use in glass products increases their durability, corrosion resistance, and thermal endurance. Lithium and Li-containing compounds are critical to lightweight structural alloys used in the aircraft industry (Wanhill, 2014).

Over the past decade, lithium has gained considerable attention as a critical mineral resource (Gardiner *et al.*, 2024). In 2024, the demand solidified lithium's position as the third most explored commodity, maintaining this ranking for a second consecutive year (S&P Global, 2024). The development of low- CO_2 technologies is driving increased lithium demand, with net-zero emissions requiring greater reliance on both new and recycled sources of lithium for batteries. The use of electric vehicles will continue to rise as countries implement bans on petrol and diesel vehicles to meet emission targets. The UK, for example, will ban the sale of new petrol and diesel vehicles from 2030 onwards, and a similar ban will come into force in 2035 across the European Union. This extensive and sustained use of lithium in technological applications has therefore steadily increased its demand and will likely continue to do so. In addition, two mineral commodities important to the manufacture of lithium-ion batteries, cobalt and lithium itself, are expected to have large capacity growth in the next few years, and in anticipation of rising demand for lithium-ion batteries, mining companies have started investing in the expansion of lithium production (USGS, 2025).

The global lithium distribution is highly heterogeneous and controlled by geological settings,

with pegmatites, brines from saline deposits, and sedimentary rock formations as the best-known deposit examples (Kesler *et al.*, 2012; Balaram *et al.*, 2024; Putzolu *et al.*, 2025). Most of the world's lithium brine resources are located in the semi-arid highlands of South America and in dry areas of the western United States and western China, whereas the lithium hard rock resources are mainly located in Australia, China, Zimbabwe, Portugal, Brazil, Canada, and Russia (Balaram *et al.*, 2024). In addition to lithium, mineral-rich brines also contain potassium, boron, and magnesium.

More than 70% of the world's lithium deposits occur in Argentina, Chile, and Bolivia (Kaya, 2022), with the first two countries accounting for ~37% of the world's reserves (USGS, 2026). Of the current global lithium supply, a significant portion (27%), comes from salars (large basins of internal drainage) in Argentina and Chile. While these salars are an important source of lithium, they occur in arid environments and support complex and valuable ecosystems. Lithium extraction thus presents significant challenges, requiring extensive resources to fully understand their complexities (Idoine *et al.*, 2024). Additionally, the extraction process raises significant social, environmental, and governance concerns, making sustainable management and responsible production a key issue for the future of lithium production.

Although hard-rock deposits dominate current global lithium production, lithium-rich brines remain the second source of lithium for global markets. In comparison with pegmatites and sedimentary deposits, lithium-rich brines are cheaper to extract and contain more reserves. In salar-type deposits, the saline brines form in continental closed basins associated with leached volcanic rocks, where high evaporation rates contribute to concentrating lithium (Munk *et al.*, 2016, 2025). These brines are waters that have leached surrounding volcanic rocks and have their lithium content greatly enhanced through evaporation. Brine, in fact, contains about 200 times more soluble solid substances than drinking water and ~70 times more than water that can hardly be used for agriculture.

Salars are unique among mineral deposits because valuable elements are found in a mobile environment (Hains, 2012). These characteristics create specific challenges for lithium exploration and sampling of brine deposits. Lithium-rich brine processing requires freshwater: mining operations have a choice of a

variety of traditional evaporation ponds and direct lithium extraction (DLE) mining technologies (Corkran *et al.*, 2022; Halkes *et al.*, 2024). These technologies involve a trade-off between net brine withdrawal and freshwater consumption: some withdraw more brine but use less freshwater, while others withdraw less brine but use more freshwater. Among other interests, lithium has also attracted global attention because of its association with extensive water use, particularly in arid regions (*e.g.*, Evans, 2014), so the need for sustainable lithium extraction is urgent as global demand increases alongside the transition to electric mobility and renewable energy storage (Cabello and Tulcanaza, 2023¹; Kirshen *et al.*, 2025). In addition, some mining companies may be expanding production from halite brines to transitional brines, creating a stronger demand for freshwater resources. DLE efforts will, however, continue to progress (International Lithium Association, 2024). Lithium-rich brine project developers are currently investing in DLE technologies alongside traditional evaporation-based extraction, which promise to reduce processing time and unlock new supplies at a better cost structure (*e.g.*, Eramet, 2024²).

By 2029, global lithium demand is expected to exceed supply, potentially leading to a critical shortage that could destabilize markets and impede the progress of green energy development (Halkes *et al.*, 2024). Forecast deficits are significantly higher than the current surpluses, and by 2034 the lithium market is expected to be over 500,000 tons (Gardiner *et al.*, 2024).

This review provides an update on the status of lithium-rich brine resources and reserves in the Central Andes of South America to identify and highlight recent development results. Basic geological information will also be included to facilitate a better understanding of these deposits. This study is based on a thorough revision of published material from a diverse number of sources and data obtained from a wide range of companies and institutions.

2. Geographical and geological setting

The Central Andean salars conceal complex hydrological systems, fossil or active, associated with rainwater, groundwater, surface water, and solutions that transport and concentrate lithium released from surrounding volcanic rocks (Corenthal *et al.*, 2016).

These salars occupy the lowlands of numerous topographically and hydrologically closed basins at elevations above 2,300 m a.s.l. and vary greatly in size (Fig. 1). At least 130 salars, saline lakes, and lagoons have been recognized, ranging in area from a few km² to about 9,000 km² (Ericksen and Salas, 1989; Fig. 1). The salars' environments typically exhibit low rainfall and high evaporation rates (*e.g.*, Munk *et al.*, 2018).

The conceptual model for salar basins and associated brine aquifers is based on studies in Chile, Argentina, and Bolivia. Salar basin locations and basin depths are typically structurally controlled but may also be influenced by volcanism that sometimes alter drainage patterns. Basin-fill deposits within salar basins usually contain bedded evaporites in the deeper, low-energy portion of the basin, together with thin to thickly bedded low-permeability lacustrine clays. Coarser-grained, higher-permeability deposits associated with active alluvial fans can typically be observed along the edges of the salar. Similar alluvial fan deposits, associated with ancient drainages, may occur buried within the basin-fill deposits.

Basins with salars are characterized by interior drainage, with no significant groundwater discharge as undercurrent. Most of the discharge that occurs within the basin is via evaporation and transpiration. Any surface water that flows into the basin either evaporates or enters the groundwater system and is eventually evaporated later. Water levels tend to be relatively shallow in the flat part of the salar. If lithium occurs in the surface water, evaporation concentrates the lithium and other constituents, resulting in a lithium-enriched brine.

The salars that contain the world's largest lithium reserves in brines are geographically confined to the plateau that encompasses southwestern Bolivia, northern Chile, and northwestern Argentina, approximately between 18° and 27° S (Fig. 1). This plateau forms an extensive morphostructure 1,800 km long and 350–400 km wide with an average elevation of 3,700 m a.s.l. and is known as Altiplano in Chile and Bolivia and Puna in Argentina (Isacks, 1988; Allmendinger *et al.*, 1997). From a geomorphological perspective, the plateau is characterized by numerous endorheic basins, many of which have a marked tectonic control and are bordered by ~N-S oriented mountain ranges (Vandervoort *et al.*, 1995). Salars with lithium-rich brines also extend in a ~N-S

¹ Cabello, J.; Tulcanaza, E. 2023. Lithium Brines in the Central Andes, key element for the transition to clean energy (Abstract). Centro de Estudios de Minerales Estratégicos y Críticos de Chile: 1 p.

² Eramet. 2024. A New Era, Investor Presentation: 42 p. <https://www.eramet.com>

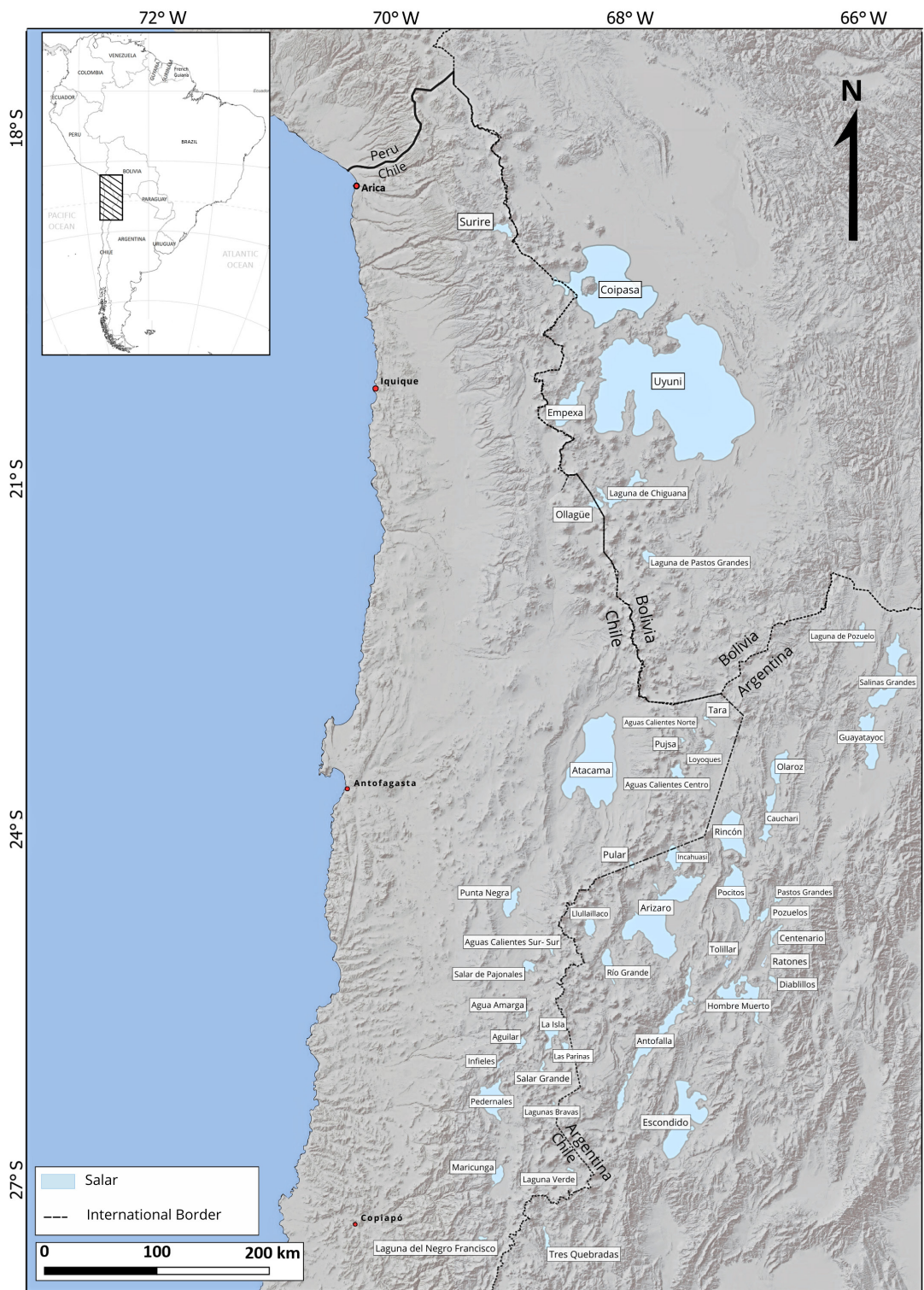


FIG. 1. Regional map of the Central Andean lithium-rich brine salars.

direction through an area of about 120,000 km² (Cabello, 2017³; Fig. 1). In Chile, important salars (Atacama, Pedernales, Maricunga) are located west of the Altiplano, at lower elevations, and at relatively more arid conditions compared to salars located east (Vila, 1975; Chong, 1988).

Most of the high-elevation mountains that border the basins hosting salars correspond to volcanoes. Lithium mobility is driven primarily by chemical weathering of these volcanic rocks, with their subsequent transport and concentration in enriched brines in a process that can take ~100 kyr (Corenthal *et al.*, 2016; Meixner *et al.*, 2020; Munk *et al.*, 2025). Most of the lithium- and salt-rich deposits formed during the Holocene by the evaporation-desiccation of lakes that reached their highest levels during the Last Glacial Maximum (Strecker *et al.*, 2007; Placzek *et al.*, 2009). The accumulation of lithium-rich brines has therefore been a consequence of this long-term interaction between volcanism, tectonism, and climate in a high-altitude environment (Munk *et al.*, 2016; Meixner *et al.*, 2020; López-Steinmetz and Salvi, 2021; Tulcanaza, 2025).

3. Production

Lithium production from brines in the Central Andes began in 1984, in the Salar de Atacama (Chile). In 1994, a second project, the Salar del Hombre Muerto in Argentina, went into production. The final commercial lithium products coming out of the processing plants at the salars are lithium carbonate and lithium chloride.

The Salar de Atacama deposits were discovered in 1969 (Moraga *et al.*, 1974), and now this project is the world's largest commercially viable lithium brine (Cabello, 2022). A drier environment compared with the more humid regions of Bolivia and Argentina, as well as fewer brine impurities and better export routes, have helped it to outpace its neighbors.

The total production (1984-2025) from two operations in the Salar de Atacama amounts to 496,000 tons of lithium. In Argentina, two operations in the Hombre Muerto and Olaroz salars have produced approximately 129,000 tons between 1994 and 2025. Collectively, these contributions total 625,000 tons of lithium and are equivalent to ~3,327,000 tons of lithium carbonate.

During 2025, Argentina's estimated lithium production was 23,000 tons, and Chile's estimated production was 56,000 tons, with both countries accounting for ~27% of the world's total (USGS, 2026). Although lithium mining companies in Chile increased the nation's output from 41,400 tons in 2023 to 56,000 tons in 2025, Chile currently ranks as the world's third-largest producer after Australia and China.

Argentina nearly doubled its lithium chemical production in 2025 compared to 2024 after the opening of the Cauchari-Olaroz and Centenario-Ratones projects. Two years before, in 2023, the Eramet Lithium Company inaugurated its DLE plant to produce battery-grade lithium carbonate on an industrial scale (Eramet, 2023⁴), and by the end of 2024, the Centenario DLE plant production was first delivered.

Bolivia does not appear to have commercial lithium production from brine, with its current activity limited to pilot-plant production. However, the country recently signed agreements to initiate industrial production. In fact, an initial investment of US\$1 billion was announced by a joint venture between Bolivia's state-owned company, Yacimientos de Litio Bolivianos (YLB), and China's lithium battery leader CATL (through its subsidiary CBC), to build two factories that are expected to produce 50,000 tons of lithium carbonate per year.

4. Prices

Lithium carbonate prices have been volatile over the past decade because of a rising demand and sudden surpluses from new lithium developments. For fixed-price contracts, the annual average U.S. lithium carbonate price was US\$37,000 per ton in 2022, almost three times as high as in 2021. Some years before, a surge in lithium demand for use in electronics, electric vehicles, and renewable energy storage led to an increase in spot carbonate prices to US\$24,000 per ton in 2017. After a surplus of new lithium projects reached commercial production in 2017 and 2018, spot prices crashed to a low of US\$12,000 per ton by the end of 2018. Prices have fluctuated due to global market conditions; for instance, recent data from July 2025 indicated prices of approximately US\$8,500-9,600 per ton, slightly higher when

³ Cabello, J. 2017. Geología y Minería de los Yacimientos de Litio en Chile: Aspectos Técnicos para una Optimización de su Desarrollo. In Jornadas de Derecho de Minería, No. 15, PowerPoint Presentation: 32 slides. Santiago.

⁴ Eramet. 2023. Centenario-Ratones Lithium Project, Power Point: 11 slides. <https://www.eramet.com>

compared to earlier lows but still influenced by oversupply and weak demand.

International groups specializing in electric vehicles and battery supply chain research reported in 2025 that global lithium-ion battery demand increased by 29%, mainly driven by rising demand across Battery Energy Storage Systems (BESS). Likewise, according to recent studies (Benchmark, 2026), demand for lithium chemicals and feedstocks is expected to increase by 14% in 2026 compared with 2025, with supply expected to increase by nearly 20% over the same period.

Lithium prices are forecast to recover and potentially enter a new bull market in 2026 (ReportLinker, 2025), with estimates generally ranging from US\$11,000 to US\$28,000 per ton.

5. Reserves

According to data published in 2026, global lithium reserves in 2025 were estimated at 37 million tons (USGS, 2026). In this same publication, Chile's reserves were estimated at 9.2 million tons, corresponding to 24.9% of the world total. Argentina was reported to have 4.4 million tons (11.9% of the world total). The known reserves in the Central Andes thus amount to 13.6 million tons of lithium, equivalent to 36.8% of the global reserves.

During the bibliographic research carried out for this review study, detailed reserves from nine salars in Argentina and two salars in Chile were investigated (Table 1). Results are: 4.166 million tons for Argentina and 12.1 million tons for Chile,

TABLE 1. CENTRAL ANDEAN LITHIUM RESERVES IN BRINES (IN SITU).

Salar	Altitude m a.s.l.	Average Li concentration (ppm)	Reserves Li (tons)	Lithium carbonate equivalent (tons)	References
ARGENTINA					
Cauchari	3,903	501	212,000	1,128,000	Allkem Ltd. (2023a)
Cauchari-Olaroz	3,903	607	683,000	3,635,000	Lithium Americas (2020)
Rincón	3,971	350	390,000	2,070,000	RTZ (2024)
Arizaro	3,475	350	92,000	490,000	Lithium Chile Inc. (2024)
Carachi Pampa-Kachi	3,007	350	117,000	624,000	Lake Resources (2025) ⁵
Pastos Grandes	3,785	439	177,000	943,000	Millennial Lithium (2019)
Centenario-Ratones	3,882	460	209,000	1,112,000	Secretaría de Minería de Argentina (2024)
Hombre Muerto (Fénix)	3,801	460	731,000	3,891,000	Livent (2023)
Hombre Muerto (West)	3,801	460	246,000	806,000	Galan Lithium Ltd. (2023) ⁶
Hombre Muerto (Sal de Vida)	3,801	460	467,000	2,486,000	Allkem Ltd. (2023b)
Hombre Muerto (Sal de Oro)	3,801	460	528,000	2,810,000	Secretaría de Minería de Argentina (2024)
Tres Quebradas	4,091	786	314,000	1,671,000	Neo Lithium Corp. (2021)
TOTAL ARGENTINA			4,166,000	21,666,000	
CHILE					
Atacama (Albemarle)	2,300	1,500	1,290,000	6,863,000	Osses (2018)
Atacama (SQM)	2,300	1,500	8,550,000	45,486,000	Fock (2019) ⁷ ; SQM (2020)
Atacama (Safety zone)	2,300	1,500	2,170,000	11,544,000	Osses (2018)
Maricunga	3,760	976	90,000	479,000	Worley Parsons (2022)
TOTAL CHILE			12,100,000	64,372,000	
TOTAL CENTRAL ANDES			16,266,000	86,038,000	

⁵ Lake Resources. 2025. Investor Presentation: 30 p.

⁶ Galan Lithium Ltd. 2023. Phase 2 DFS, Hombre Muerto West, ASX Announcement: 55 p.

⁷ Fock, A. 2019. Evaluación de Recurso In situ-Reserva Base en el Salar de Atacama, Gerencia de Hidrogeología Salar, SQM, Power Point Presentation, 25 slides.

representing a total of 16.266 million tons of lithium for the two countries.

6. Resources

The USGS (2026) Measured and Indicated (M+I) resource information for the Central Andes totals 64 million tons of lithium. That report allocated 28 million tons to Argentina, 23 million tons to Bolivia, and 13 million tons to Chile; however, it does not provide information on the sources. According to these statistics, the Central Andes represents nearly 43% of the worldwide lithium resources, which total 150 million tons. Out of these three countries, Bolivia possesses the world's second-largest identified lithium resources and is home to the Salar de Uyuni, which is the world's single-largest lithium deposit (USGS, 2026). Although the deposit holds resources of 20 million tons (Yacimientos de Litio Bolivianos, 2018), it remains unexploited on an industrial scale.

The economic value of lithium-rich brine in the Central Andes is reflected in several available studies. For this review, detailed resource information was obtained for 43 salars, including 19 in Argentina, three in Bolivia, and 21 in Chile (Table 2). Resources are segregated into approximately 23.5 million tons in Argentina, 23 million tons in Bolivia, and 15.5 million tons in Chile. This information includes the M+I resource only. Inferred resources have been excluded yet they represent an important subject for future exploration activities.

7. Exploration

In the context of exploration activities, Argentina reports 20 advanced projects, including the Arizaro, Centenario, Incahuasi, and Río Grande salars, among others (Secretaría de Minería de Argentina, 2024). In Bolivia, as reported in local newspapers, successful exploration has been conducted in the Coipasa and Pastos Grandes salars; corresponding activities will soon follow in the Capina, Cañapa, Chiguana, and Empexa salars. In Chile, the Salares Altoandinos project of the National Mining Enterprise (Enami) was undergoing an exploration campaign in the Aguilar, La Isla, and Grande salars as part of the National Lithium Strategy, with promising results (Enami, 2025⁸). The current data on Salar de La Isla complements the positive results released in April 2025 for the Salar de Aguilar, which showed an average total lithium concentration of 740 mg/l for this deposit, with a

maximum of 984 mg/l (Enami, 2025⁸). Advanced exploration activities have also been reported in Chile at the Laguna Verde Project (CleanTech, 2025). Recently, Codelco announced additional exploration to be completed at its Salar de Maricunga project.

Upon reviewing the list of Central Andean lithium deposits in brines with informed reserves and/or resources, it can be observed that exploration efforts have been generally successful. Future tasks could be to assess the total amount of reported inferred resources from ancillary information, or to investigate in detail some of the economically relevant salars. New efforts in regional, remote-based reconnaissance (e.g., Rossi *et al.*, 2022) could be effective for a screening-scale recognition of new closed basins and small salars of potential economic interest.

8. Conclusions

Lithium is found in economic concentrations in numerous salars in the Central Andes of Argentina, Bolivia, and Chile, a zone that has become one of the most important mining regions in the world. The occurrence of lithium-rich brine deposits is a consequence of several interrelated factors, including tectonism, igneous or geothermal activity, denudation processes, arid climate conditions, and a closed hydrological system. Typically, these deposits have a nucleus formed by evaporation processes, which is where the highest lithium concentrations are found. Lithium is extracted from volcanic rocks by weathering, transported downslope, and then accumulated in the salars in a process that can take ~100 kyr.

Chilean lithium operations between 1984 and 2025 amount to 496,000 tons. In Argentina, they totaled ~129,000 tons between 1994 and 2025. These numbers imply a combined production of 625,000 tons. In 2025, Argentina's estimated lithium production was 23,000 tons, and 56,000 tons were estimated for Chile, with both countries accounting for almost 27% of the global production in that year.

Together, Argentina and Chile hold 13.6 million tons of lithium reserves, representing 36.8% of the global reserves. These amounts do not differ much after comparing official global sources (U.S. Geological Survey) to the data reported by the companies and analyzed in this review.

According to Measured and Indicated (M+I) resource information, out of the 150 million tons of worldwide identified lithium resources, Argentina holds 28 million tons, Bolivia 23 million tons,

⁸ Enami. 2025. Comunicado de Prensa: Recursos Salares La Isla y Aguilar. Empresa Nacional de Minería: 2 p. <https://www.enami.cl>

TABLE 2. CENTRAL ANDEAN M+I LITHIUM RESOURCES IN BRINE.

Salar	Altitude m a.s.l.	Average Li content (ppm)	Resources M+I (tons)	Lithium carbonate equivalent (tons)	References
ARGENTINA					
Olaroz	3,903	632	2,890,000	15,380,000	Allkem Ltd. (2023c)
Cauchari-Olaroz	3,903	592	3,730,000	19,853,000	Lithium Americas (2020)
Cauchari	3,903	519	623,000	3,300,000	Allkem Ltd. (2023a)
Salinas Grandes	3,725	326	45,000	240,000	Orocobre Ltd. (2012)
Rincón	3,971	672	1,770,000	9,390,000	RTZ (2024)
Rincón (West)	3,971	258	30,000	157,000	Power Minerals (2023a)
Rincón (Argosy)	3,971	326	114,000	606,000	Argosy Minerals Ltd. (2023)
Incahuasi	3,601	198	44,000	235,000	Power Minerals (2023b)
Pular	3,579	87	17,000	91,000	PepinNini (2019) ⁹
Pastos Grandes	3,785	331	780,000	4,152,000	Reidel (2023)
Pastos Grandes (PPG)	3,785	431	176,000	939,000	LSC Lithium Corp. (2019)
Pozuelos (PPG)	3,663	518	315,000	1,678,000	LSC Lithium Corp. (2019)
Arizaro	3,475	297	469,000	2,498,000	Lithium Chile Inc. (2024)
Llullaillaco-Mariana	3,755	315	831,000	4,410,000	Secretaría de Minería de Argentina (2024)
Centenario-Ratones	3,882	407	986,000	5,249,000	Eramet (2024) ¹⁰
Río Grande	3,668	576	499,000	2,658,000	NOA Lithium Brines Inc. (2025) ¹¹
Tolillar	3,625	232	681,000	3626000	Alpha Lithium (2023)
Diablillos (Sal de los Ángeles)	4,032	501	308,000	1640000	Secretaría de Minería de Argentina (2024)
Hombre Muerto (Candelas)	3,971	672	129,000	685,000	Johanis (2024)
Hombre Muerto (West)	3,801	712	1,075,000	5,723,000	Galan Lithium Ltd. (2023) ¹²
Hombre Muerto (Virgen del Valle)	3,971	736	213,000	1,134,000	Johanis (2024)
Hombre Muerto (Fénix)	3,801	921	1,328,000	7,071,000	Johanis (2024)
Hombre Muerto (Sal de Vida)	3,801	795	1,220,000	6,520,000	Johanis (2024)
Hombre Muerto (Norte)	3,725	376	298,000	1,583,000	Lithium South (2024)
Hombre Muerto (Sal de Oro)	3,801	258	297,000	1,580,000	Secretaría de Minería de Argentina (2024)
Antofalla	3,331	350	2,218,000	11,800,000	Johanis (2024)
Carachi Pampa-Kachi	3,007	218	1,371,000	7,300,000	Lake Resources (2025) ¹³
Tres Quebradas	4,091	625	1,009,000	5,369,000	Neo Lithium Corp. (2021)
TOTAL ARGENTINA			23,466,000	124,867,000	
BOLIVIA					
Coipasa	3,656	460	1,800,000	9,756,000	Yacimientos de Litio Bolivianos (2024)
Uyuni	3,653	450	21,000,000	111,720,000	Yacimientos de Litio Bolivianos (2018)
Pastos Grandes	4,330	1,500	200,000	1,064,000	Yacimientos de Litio Bolivianos (2024)
TOTAL BOLIVIA			23,000,000	122,540,000	

⁹ PepinNini. 2019. ASX Release JORC Resource Restatement Sulfa Mina on Salar de Pular, Salta Lithium Project, Argentina: 27 p.

¹⁰ Eramet. 2024. A New Era, Investor Presentation: 42 p. <https://www.eramet.com>

¹¹ NOA Lithium Brines Inc. 2025. Corporate Presentation NOAL: TSX-V Río Grande Resources: 21 p.

¹² Galan Lithium Ltd. 2023. Phase 2 DFS, Hombre Muerto West, ASX Announcement: 55 p.

¹³ Lake Resources. 2025. Investor Presentation: 30 p.

table 2 continued.

Salar	Altitude m a.s.l.	Average Li content (ppm)	Resources M+I (tons)	Lithium carbonate equivalent (tons)	References
CHILE					
Surire	4,260	400	180,000	958,000	Prokurika (2018) ¹⁴
Ollague-Kuska	3,705	175	139,000	741,000	Wealth Minerals Ltd. (2024)
Atacama	2,300	1,800	8,200,000	43,649,000	SQM (2020)
Tara	4,330	350	55,000	293,000	Osses (2023) ¹⁵
Aguas Calientes Norte	4,280	150	8,000	43,000	Osses (2023) ¹⁵
Pujsa	4,500	350	20,000	106,000	Osses (2023) ¹⁵
Quisquiro	4,150	350	80,000	426,000	Osses (2023) ¹⁵
Aguas Calientes Centro	4,200	150	65,000	346,000	Osses (2023) ¹⁵
Capur	3,950	350	15,000	80,000	Osses (2023) ¹⁵
Punta Negra	2,945	280	220,000	1,170,000	Prokurika (2018) ¹⁴
Aguas Calientes 4	3,665	150	11,000	59,000	Osses (2023) ¹⁵
Pajonales	3,537	120	116,000	615,000	Carrasco and Cádiz (2020)
La Isla	3,950	914	3,700,000	19,800,000	Enami (2025) ⁸
Las Parinas	3,987	235	201,000	1,069,000	Enami (2023) ¹⁶
Aguilar	3,320	524	920,000	4,900,000	Enami (2025) ⁸
Infieles	3,520	161	32,000	170,000	Enami (2023) ¹⁶
Pedernales	3,370	350	375,000	1,995,000	Prokurika (2018) ¹⁴
Lagunas Bravas	4,250	310	3,000	14,000	Hiner (2010)
Laguna Negro Francisco	4,150	207	83,000	440,000	CleanTech (2025)
Laguna Verde	4,350	175	810,000	1,630,000	CleanTech (2025)
Maricunga	3,760	953	358,000	1,905,000	Worley Parsons (2022)
TOTAL CHILE			15,591,000	80,409,000	
TOTAL CENTRAL ANDES			62,057,000	327,816,000	

and Chile 13 million tons (using U.S. Geological Survey information). Therefore, the Central Andes holds 64 million tons of lithium, almost 43% of the world’s resources. When comparing these global statistics with information reported by the companies, Argentina has 23.5 million and Chile 13.4 million (Bolivia remains the same), totaling ~60 million tons (~37.7% of the world’s resources).

Lithium has been positioned as one of the world’s most explored commodities. This tendency is also well represented by the activities in the Central Andes, where, according to the analysis of the identified reserves and/or resources, it can be observed that

exploration efforts have been successful. All the aspects highlighted in this review explain and justify the ongoing presence of Chile, Argentina, and Bolivia as major players in the global lithium industry.

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¹⁴ Prokurika, B. 2018. Mercado del Litio y Situación en Chile. Ministerio de Minería, PowerPoint: 15 slides. Santiago.
¹⁵ Osses, L. 2023. Inversiones, Desarrollo y Prefactibilidad de un nuevo proyecto de litio en el Salar de Atacama. Foro del Litio: 14 p. <https://www.forolitio.cl>
¹⁶ Enami. 2023. Proyecto Salares Altoandinos. Empresa Nacional de Minería: 11 p. <https://www.enami.cl>

References

- Allkem Ltd. 2023a. Cauchari Lithium Brine Project. SEC Technical Report Summary, Allkem Limited-Australia: 283 p.
- Allkem Ltd. 2023b. Sal de Vida Lithium Brine Project, Alkem Limited -Australia: 345 p.
- Allkem Ltd. 2023c. Olaroz Lithium Facility, Feasibility Study , Alkem Limited -Australia: 321 p.
- Allmendinger, R.W.; Jordan, T.E.; Kay, S.M.; Isacks, B.L. 1997. The evolution of the Altiplano-Puna plateau of the Central Andes. *Annual Reviews of Earth and Planetary Science* 25: 139-174. <https://doi.org/10.1146/annurev.earth.25.1.139>
- Alpha Lithium. 2023. Tolillar project, NI 43-101. Technical Report, Alpha Lithium Corporation – Canada : 307 p.
- Argos y Minerals Ltd. 2023. Annual Report, Rincon Lithium Project Argosy Minerals Limited -Australia: 63 p.
- Balaram, V.; Santosh, M.; Satyanarayanan, M.; Srinivas, N.; Gupta, H. 2024. Lithium: A review of applications, occurrence, exploration, extraction, recycling, analysis, and environmental impact: *Geoscience Frontiers*. Elsevier 15 (5): 1-47. <https://doi.org/10.1016/j.gsf.2024.101868>.
- Benchmark. 2026. Outlook Whitepaper: ¿A Turning Point for Critical Materials? Benchmark Publication: 37 p.
- Cabello, J. 2022. Reservas, recursos y exploración de litio en salares del norte de Chile. *Andean Geology* 49 (2): 297-306. <http://dx.doi.org/10.5027/andgeoV49n2-3444>
- Carrasco, R.; Cádiz, N. 2020. Potencial de litio en el salar de Pajonales, región de Antofagasta, Chile. Servicio Nacional de Geología y Minería, Informe Registrado IR-20-85 (Inédito): 95 p. Santiago.
- Chong, G. 1988. The Cenozoic saline deposits of the Chilean Andes between 18°00' and 27°00' south latitude. *In* The Southern Central Andes: contribution to structure and evolution of an Active Continental Margin (Bahlburg, H.; Breitkreutz, C.; Giese, P.; editors). Lecture notes in Earth Sciences, Springer Verlag 17: 137-151. Heidelberg. <https://doi.org/10.1007/BFb0045179>
- CleanTech. 2025. Laguna Verde Resource Update. CleanTech Lithium PLC: 50 p.
- Corenthal, L.; Boutt, D.; Hynek, S.A.; Munk, L.A. 2016. Regional groundwater flow and accumulation of a massive evaporite deposit at the margin of the Chilean Altiplano. *Geophysical Research Letters* 43 (15): 8017-8025. <https://doi.org/10.1002/2016GL070076>
- Corkran, D.; Boutt, D.F.; Munk, L.A.; Morán, B.J.; McKnight, S.V.; Kirshen, A. 2022, Modeling the impacts of Lithium Brine Mining on Water Resources in South American Salars. *Lithium Solutions*, UMass Amherst. College of Natural Sciences, UAA: 3 p.
- Ericksen, G.E.; Salas, R. 1989. Geology and resources of salars in the central Andes in the geology of the Andes and its relation to hydrocarbon and mineral resources. *Circum-Pacific Council for Energy and Mineral Resources, Earth Science Series* 11. Chapter 10: 151-164. Houston, Texas.
- European Commission. 2023. Study on the Critical Raw Materials for the EU 2023, Final Report: 158 p.
- Evans, K. 2014. Lithium. *In* Critical Metals Handbook, Edited by Gus Gunn, John Wiley & Sons: 230-260. <https://doi.org/10.1002/9781118755341.ch10>
- Gardiner, N.; Jowitt, S.; Sykes, J. 2024. Lithium: ¿critical or no so critical? *Geoenergy*: 6 p.
- Hains, D.H. 2012. Best Practice Guidelines for Resource and Reserve Estimation for Lithium Brines. Canadian Institute of Mining, Metallurgy and Petroleum (CIM): 10 p.
- Halkes, R.T.; Hughes, A.; Wall, F.; Petavratzi, E.; Pell, R.; Lindsay, J.J. 2024. Life cycle assessment and water use impacts of lithium production from salar deposits: Challenges and opportunities. *Resources, Conservation and Recycling* 207: 15 p. <https://doi.org/10.1016/j.resconrec.2024.107554>
- Hiner, J.E. 2010. NI-43-101 Technical Report on the Laguna Brava Project Third Region, Copiapó, Chile. Etna Resources Inc.: 37 p.
- Idoine, N.E.; Raycraft, E.R.; Hobbs, S.F.; Everett, P.; Evans, E.J.; Mills, A.J.; Currie, D.; Horn, S.; Shaw, R.A. 2024. World mineral production 2018-2022. *British Geological Survey*: 99 p. Nottingham.
- International Lithium Association. 2024. Direct Lithium Extraction (DLE): An Introduction. Rockwell Automation: 26 p. Londres.
- Isacks, B.L. 1988. Uplift of the Central Andean Plateau and bending of the Bolivian Orocline. *Journal of Geophysical Research* 93 (B4): 3211-3231. <https://doi.org/10.1029/JB093iB04p03211>
- Johanis, P.E. 2024. Actualización de los recursos informados de litio en salmueras en la República Argentina. Servicio Geológico Minero Argentino, Instituto de Geología y Recursos Minerales: 6 p. Buenos Aires. <https://repositorio.segemar.gov.ar/handle/308849217/4441>
- Kaya, M. 2022. State-of-the-art lithium-ion battery recycling technologies. *Circular Economy* 1 (2): 100015. <https://doi.org/10.1016/j.cec.2022.100015>
- Kesler, S.; Gruber, P.; Medina, P.; Keolian, G.; Everson, M.; Wallington, T. 2012. Global lithium resources: Relative importance of pegmatite, brine and other deposits. *Ore Geology Reviews* 48: 55-69. <https://doi.org/10.1016/j.oregeorev.2012.05.006>

- Kirshen, A.B.; Moran, B.J.; Munk, L.A.; Russo, A.A.; McKnight, S.V.; Jenckes, J.; Corkran, D.B.; Bresee, M.; Boutt, D.F. 2025. Freshwater inflows to closed basins of the Andean plateau in Chile, Argentina, and Bolivia. *Communications Earth & Environment* 6 (177): 11 p. <https://doi.org/10.1038/s43247-025-02130-6>
- Lithium Americas. 2020. Lithium Carbonate Production at Cauchari-Olaroz Salars, NI 43-101. Technical Report ,Updated Feasibility Study- Argentina : 390 p.
- Lithium Americas, 2023, Lithium Resources Update, Pastos Grandes NI 43-101. Technical Report Salta Province Argentina : 170 p. Salta.
- Lithium Chile Inc. 2024. Salar de Arizaro Project NI 43-101. Technical Report and Pre-feasibility Study: 393 p. Salta.
- Lithium South. 2024. Preliminary Economic Assessment (PEA) - Hombre Muerto North Lithium Project NI 43-101. Technical Report: 285 p. Salta.
- Livent. 2023. Resource and Reserve Report, Pre-Feasibility Study, Salar del Hombre Muerto, NI 43-101. Technical Report: 196 p. Salta..
- López-Steinmetz, R.; Salvi, S. 2021. Brine grades in Andean salars: When basin size matters A review of the Lithium Triangle. *Earth-Science Reviews* 217: 117 p. <https://doi.org/10.1016/j.earscirev.2021.103615>
- LSC Lithium Corp. 2019. Preliminary Economic Assessment (PEA) - Pozuelos - Pastos Grandes Project NI 43-101. Technical Report , GHD -Report for LSC Lithium Corporation: 273 p. Salta.
- Lusty, P.; Shaw, R.; Gunn, A.; Idoine, N. 2021. UK criticality assessment of technology, critical minerals, and metals. British Geological Survey Commissioned Report CR/21/120: 76 p.
- Meixner, A.; Sarchi, C.; Lucassen, F.; Becchio, R.; Caffè, P.; Lindsay, J.; Rosner, M.; Kasemann, S. 2020. Lithium concentrations and isotope signatures of Palaeozoic basement rocks and Cenozoic volcanic rocks from the Central Andean arc and back-arc. *Mineralium Deposita* 55 (6): 1071-1084. <https://doi.org/10.1007/s00126-019-00915-2>
- Millennial Lithium. 2019. Feasibility Study of the Pastos Grandes Project NI 43-101. Worley Parsons Technical Report for Millennial Lithium : 650 p. Salta.
- Moraga, A.; Chong, G.; Fortt, M.A.; Henríquez, H. 1974. Estudio Geológico del Salar de Atacama, Provincia de Antofagasta. Instituto de Investigaciones Geológicas, Boletín 29: 56 p. Santiago.
- Munk, L.A.; Hynek, S.; Boutt, D.; Labay, K.; Jochens, H. 2016. Lithium Brines: A Global Perspective. *In* Rare Earth and Critical Elements in Ore Deposits. Reviews in Economic Geology, chapter 14 (Verplanch, P.L.; Hitzman M.W; editors). Society of Economic Geologists 18: 339-365. <https://doi.org/10.5382/Rev.18.14>
- Munk, L.A.; Boutt, D.; Hynek, S.; Moran, B. 2018. Hydrogeochemical fluxes and processes contributing to the formation of lithium-enriched brines in a hyper-arid continental basin. *Chemical Geology* 493: 37-57. <https://doi.org/10.1016/j.chemgeo.2018.05.013>
- Munk, L.A.; Boutt, D.; Butler, K.; Russo, A.; Jenckes, J.; Moran, B.; Kirshen, A. 2025. Lithium Brines: Origin, Characteristics, and Global Distribution. *Economic Geology* 120 (3): 575-597. <https://doi.org/10.5382/econgeo.5134>
- Neo Lithium Corp. 2021. Preliminary Feasibility Study (PFS) - 3Q Project NI 43-101. Technical Report GWI & Worley FS Report for NEO Lithium Corp.: 368 p. Catamarca.
- Orocobre Ltd. 2012. Technical Report on the Salinas Grandes Lithium Project NI 43-101. Hydrominex Geoscience Technical Report: 336 p. Salta.
- Osses, L. 2018. El Futuro del Litio hacia el 2025. Instituto de Ingenieros de Minas de Chile (IIMCh). *Minerales* 289: 8 p.
- Placzek, C.; Quade, J.; Betancourt, J.; Patchett, J.; Rech, J.; Latorre, C.; Matmon, A.; Holmgren, N.; English, N. 2009. Climate in the Dry Central Andes over Geologic, Millennial, and Interannual time scales. *Annals of the Missouri Botanical Garden* 96 (3): 386-397. <https://doi.org/10.3417/2008019>.
- Power Minerals. 2023a. Major JORC Mineral Resource at Salta Lithium Project, ASX Press Release – Australia : 23 p.
- Power Minerals. 2023b. Substantial Lithium Brine Resource at Incahuasi Salar, ASX Press Release – Australia : 22 p.
- Putzolu, F.; Armstrong, R.N.; Benson, T.R.; Boutt, D.F.; Butler, K.L.; Dolgoplova, A.; Herrington, R.J.; Ibarra, D.E.; Munk, L.A. 2025. Volcano-Sedimentary Deposits: Overview of an Emerging Type of Lithium Resource. *Economic Geology* 120 (3): 541-573. <https://doi.org/10.5382/econgeo.5135>
- Reidel, F. 2023. Lithium Resources Update Pastos Grandes Project NI 43-101. Technical Report: 170 p. Salta.
- Report Linker. 2025. Lithium Market Reports 2025 - Trends, Outlook and Forecasts: 5p.
- Rossi, C.; Bateson, L.; Bayarara, M.; Butcher, A.; Ford, J.; Hughes, A. 2022. Framework for Remote Sensing and Modelling of Lithium-Brine Deposit Formation. *Remote Sensing* 14 (6): 1383. <https://doi.org/10.3390/rs14061383>

- RTZ. 2024. RTZ, ASX, Rincon Project Mineral Resources and Ore Reserves, Rio Tinto Press Release – England-Australia: 36 p.
- S&P Global. 2024. Exploration Insights CES 2024. Summary Report: 15 p.
- Secretaría de Minería de Argentina. 2024. Portfolio of Advanced Projects. Lithium: 59 p.
- SQM. 2020. Annual Report 2020. Sociedad Química y Minera de Chile S.A.: 396 p.
- Strecker, M.; Alonso, R.; Bookhagen, B.; Carrapa, B.; Hilley, G.; Sobel, E.; Trauth, M. 2007. Tectonics and Climate of the Southern Central Andes, Annual Review of Earth and Planetary Sciences: 35: 747-87. <https://doi.org/10.1146/annurev.earth.35.031306.140158>
- Tankou, A.; Hall, D. 2026. Technologies and policy levers for more sustainable batteries. ZEV ALLIANCE: International Council, Austria- UK, 43 p. www.zevalliance.org
- Tulcanaza, E. 2025. Towards sustainable extraction of lithium-bearing resources: role of natural capital in the High Andes business strategies. Minerals Economics 38: 653-664. <https://doi.org/10.1007/s13563-025-00513-x>
- USGS. 2025. World minerals outlook to 2029-Cobalt, gallium, helium, lithium, magnesium, palladium, platinum, and titanium data. U.S. Geological Survey, Scientific Investigations Report 2025-5021: 28 p. <https://doi.org/10.5066/P1HTTCWN>
- USGS. 2026. Lithium. U.S. Geological Survey, Mineral Commodity Summaries: 2 p. <https://pubs.usgs.gov>
- Vandervoort, D.; Jordan, T.; Zeitter, P.; Alonso, R. 1995. Chronology of internal drainage development and uplift, Southern Puna plateau, Argentina central Andes. Geology 23: 145-148.
- Vila, T. 1975. Geología de los Depósitos Salinos Andinos, Provincia de Antofagasta. Revista Geológica de Chile 2: 41-55. Santiago.
- Wanhill, R.J.H. 2014. Aerospace Applications of Aluminum-Lithium Alloys. In Aluminum-lithium Alloys, Chapter 15 (Prasad, N.E.; Gokhale, A.A.; Wanhill, R.J.H.; editors). Elsevier: 503-535. <https://doi.org/10.1016/B978-0-12-401698-9.00015-X>
- Wealth Minerals Ltd. 2024. Technical Report NI 43-101, prepared by DRA Global Limited: Preliminary Economic Assessment - Kuska Project Region of Antofagasta, Chile: 178 p.
- Worley Parsons. 2022. Technical Report NI 43-101 Definitive Feasibility Study Stage One, prepared by Atacama Water Consultants for Minera Salar Blanco Atacama Region, Chile: 416 p.
- Yacimientos de Litio Bolivianos. 2018. Memoria 2018. Yacimientos de Litio Bolivianos: 100 p. <https://www.ylb.gob.bo>
- Yacimientos de Litio Bolivianos. 2024. Rendición Pública de Cuentas Final. Yacimientos de Litio Bolivianos: 15 p. <https://www.ylb.gob.bo>