THE LITHIUM VOICE
INTERNATIONAL LITHIUM ASSOCIATION (ILiA)
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Lithium from clay

GBA's Battery Passport

In conversation with Dr Hernán Cáceres

LITHIUM GLASS-CERAMICS

ESSENTIAL FOR GIANT TELESCOPES

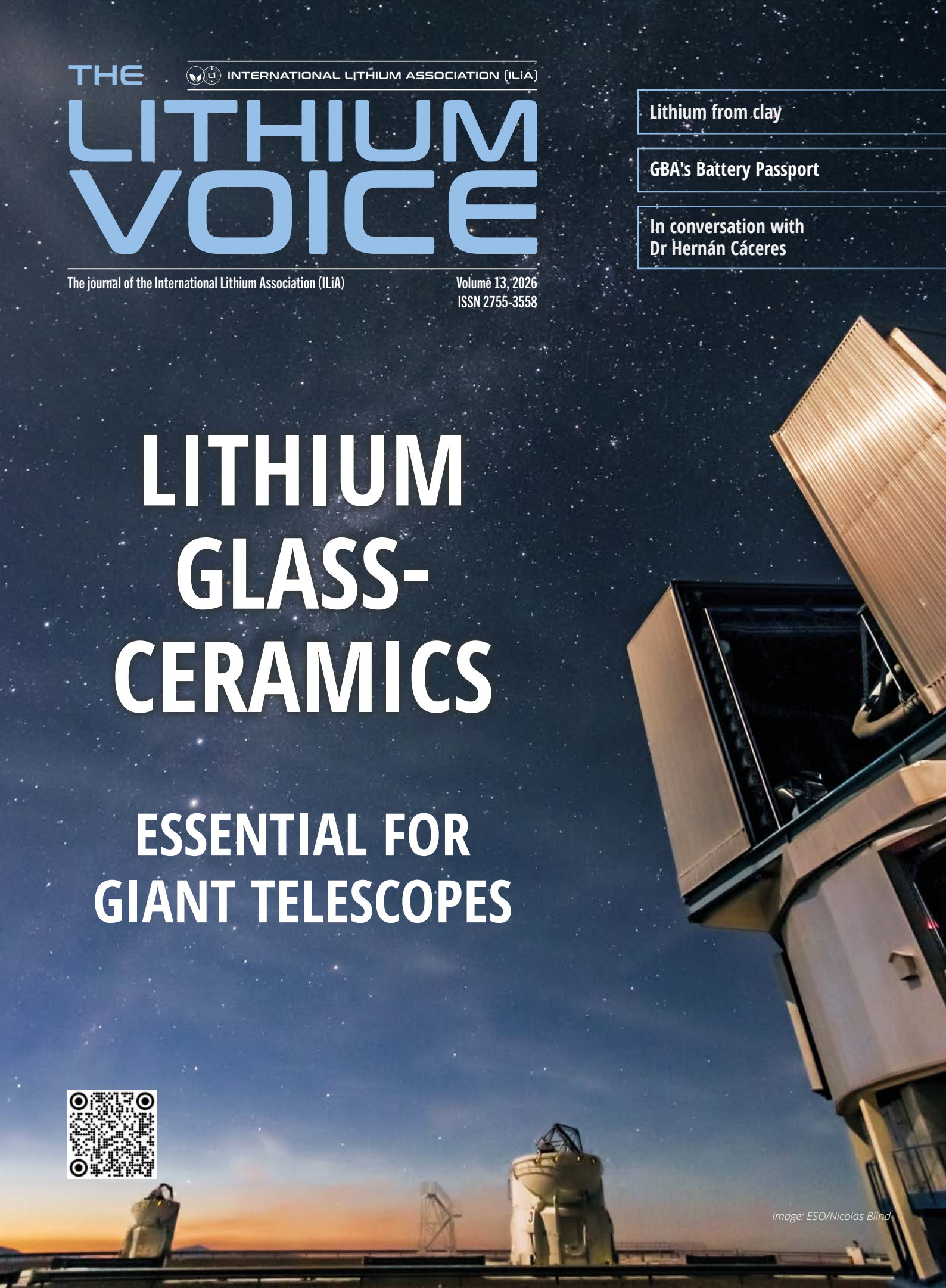


Image: ESO/Nicolas Blind

THE CURRENT

Catch up with ILiA's work at a glance

The ISO and lithium

The International Organization for Standardization (ISO) has published over 25,000 international standards covering almost all aspects of technology and manufacturing, and now its attention as turned to lithium.

In 2020 the ISO established Technical Committee 333 with a mandate to develop international standards covering the full lithium value chain, including lithium mining, concentration, extraction, separation, and conversion into commercially valuable lithium compounds and materials (such as oxides, salts, metals, master alloys, and materials for lithium-ion batteries).

The committee's work program encompasses the development of standardized terminology, technical delivery conditions to address transportation challenges, and harmonized testing and analytical methods aimed at improving the overall quality and consistency of lithium products.

ILiA is an official observer of TC 333 and engages in its work 'Carbon Footprint Standard for Lithium Products', sustainability and management.

Carbon footprint of lithium

The work of ISO Working Group 9 (WG 9) focuses on carbon footprint. It focuses on key lithium products such as lithium carbonate and lithium hydroxide, produced from various resources including brines and spodumene, with possible future expansion to recycled lithium compounds. The objective is to establish a consistent, practical, and comparable methodology and standard for calculating greenhouse gas emissions across the lithium value chain.

One of the key initiatives of this group is based on a proposal submitted by the Japanese delegation through the Japan Industrial Standard Committee. This proposal to develop an ISO standard is based on the ILiA Lithium Product Carbon Footprint (PCF) Guidance published in 2024 and recognises it as a key industry reference.

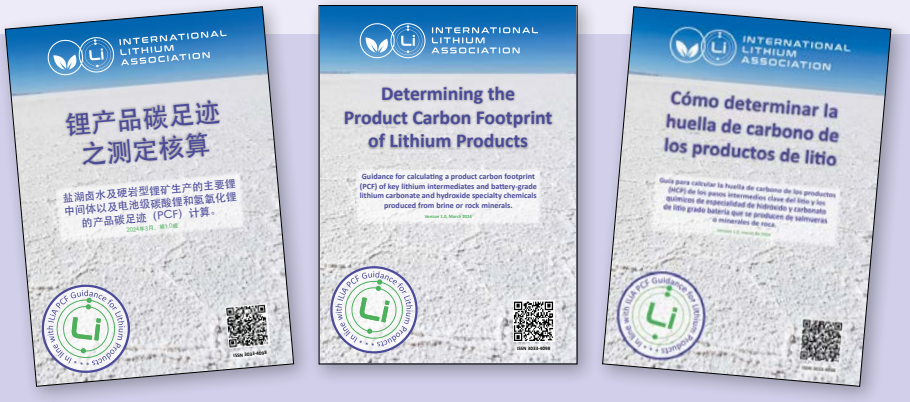
A second initiative is being developed following a proposal from the Chinese delegation. This draws on ILiA's PCF Guidance to consider developing standards for a carbon footprint framework for lithium produced from black mass (battery waste) recycling.

ILiA's role in advancing this necessary work was described by Blandine García, ISO Technical Programme Manager for TC 333: "Through its PCF Guidance and active stakeholder engagement, ILiA supports the translation of sustainability principles into practical, consistent carbon footprint assessment approaches, providing TC 333 with real-world value chain insights that help ensure emerging standards are robust, implementable, and environmentally sound."

ILiA's leadership role

Xiao Lin, the Convenor of ISO/TC 333 WG 9 and CEO of Botree Recycling Technologies, described ILiA's role in the sustainable development of the industry during our collaboration as "exemplary", explaining that ILiA's PCF Guidance embodies the collective wisdom of over 45 global institutions and fills a critical gap in the industry. This guideline not only establishes a unified basis for accounting but also explicitly supports third-party certification, providing a solid underpinning for mutual trust across the upstream and downstream of the industrial chain.

Further details about TC 333 can be found at www.iso.org.



Product Carbon Footprint (PCF) guidance for lithium products is available free in English, Spanish and Chinese on our website

ILiA's landmark guidance on calculating the PCF of your lithium products is freely available as part of the Association's mission to share relevant information about the lithium industry as widely as possible. All three editions are available from **www.lithium.org**.

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Chair's WELCOME

Welcome to the 13th edition of *The Lithium Voice*.

As demand for batteries grows, global interest in related topics such as carbon emissions, labour conditions, and the recycled content of batteries has also grown. At the International Lithium Association (ILiA) promoting a sustainable and responsible value chain is one of our core values. This is reflected in our work, which includes helping regulators to understand the work done by our members, and creating the standardised Product Carbon Footprint Guidance which has been widely adopted by the industry and key stakeholders.

The Global Battery Alliance (GBA) is one of the key areas where ILiA's work directly contributes to an international effort focused on promoting greater transparency in the industry. Our Guidance, taken in conjunction with similar advice from the Nickel Institute and Cobalt Institute, feeds into the GBA's Battery Passports, which in coming years will become widespread in the electric vehicle (EV) industry.

This message of responsible value chains is echoed in the Spotlight on Sustainability which discusses how Mercedes-Benz is working with suppliers to ensure value chain alignment around sustainability values. One of the key messages here is that mining companies do not need to outperform necessarily from the beginning. It is more important that they show progress and transparency. What is relevant to the EV manufacturers is that miners improve their sustainability performance over time.

In this edition our interview is with Dr Hernán Cáceres, the Executive Director at Chile's Instituto Nacional de Litio y Salares (INLiSa), a government-backed institution. One of INLiSa's ambitions is to help increase Chile's participation in that value chain — not by replacing industry, but by enabling knowledge, technology and coordination so that more of the transformation can happen in Chile.

Finally, in our latest article to explore the unique and inimitable uses of lithium there are some very surprising applications, which even established lithium experts might be surprised to discover! Lithium truly is a remarkable element and by working together we can ensure that it is produced in a sustainable and responsible way too.

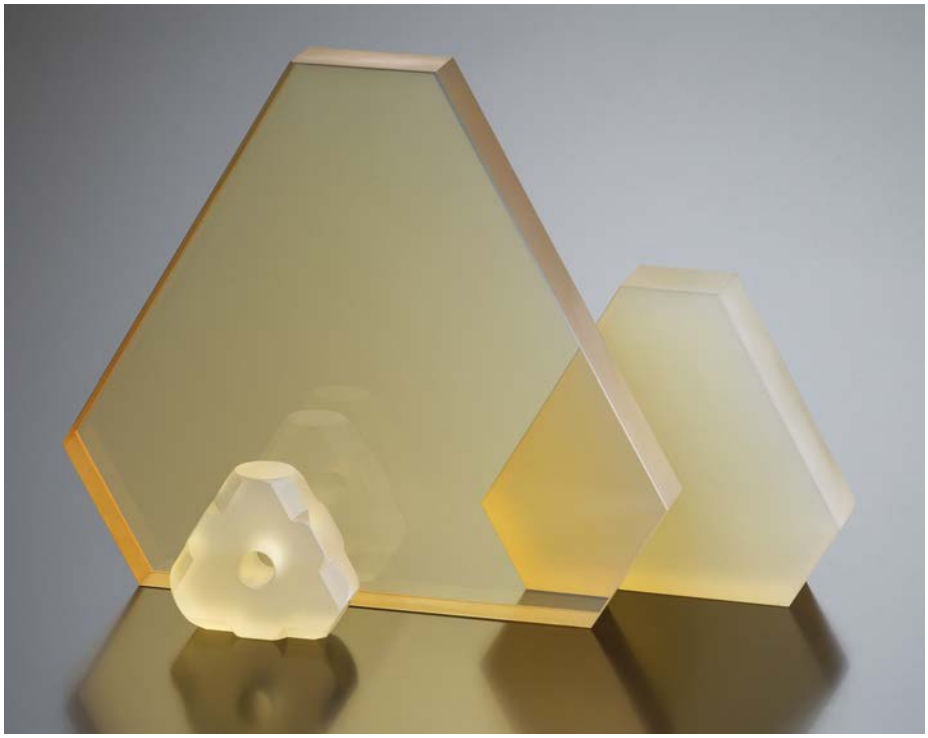
Thanks!

Anand Sheth
Founding Chairman

Feature

AMAZING LITHIUM GLASS-CERAMICS

Regular readers of *The Lithium Voice* will know that the lithium atom has unique properties which have allowed for many remarkable applications to be developed. In this edition we explore the use of lithium in glass-ceramics and examine the case study of ZERODUR®, a glass-ceramic with a near-zero thermal expansion over a wide temperature range that is made by SCHOTT in Germany and is used to construct the largest telescopes ever built.



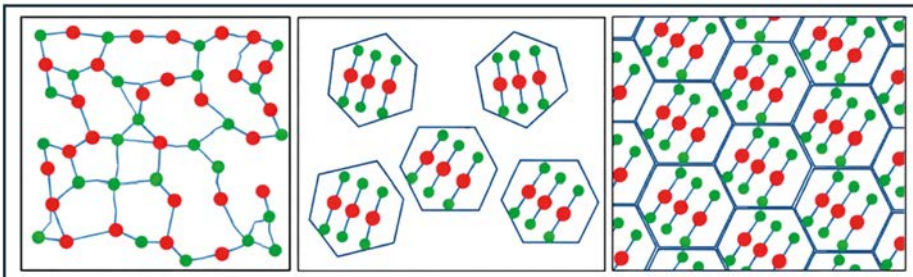
CNC-shaped and double-side polished blanks made from ZERODUR® lithium-aluminosilicate glass-ceramic. *(Image: SCHOTT)*

What are glass-ceramics?

Glass-ceramics share properties with both glass and ceramics, but don't be fooled - they are their own unique category of materials. This becomes clear when they are studied at the microscopic level. While glasses are characterized by a random (amorphous) non-crystalline structure, ceramics are made up of small crystalline areas called grains.

Glass-ceramics exhibit a hybrid internal structure that mixes fine-grained crystalline phases with an amorphous glass matrix to glass-ceramics unique properties. For example, their strength far exceeds pure glass, but unlike pure ceramics, many glass–ceramics show high translucency or can even be fully transparent.

Prior to the development of rechargeable batteries, glass-ceramics was one of the largest and most important uses of lithium carbonate and the lithium mineral, spodumene. For many years ILiA's Founding Chairman, Anand Sheth, supplied lithium for glass-ceramic applications; Anand told *The Lithium Voice* that, "the low iron spodumene, unique to the Greenbushes mine in Australia, was highly desirable for this application and is still used by it today".



Schematic of microstructure differences of a) randomly arranged atoms in glass, b) a glass-ceramic with crystalline grains within a glass matrix, and c) crystalline grains in a ceramic. *(After Fu, Engqvist & Xia 2020)*

The origin of glass-ceramics

Glass-ceramics were discovered through a happy accident in 1953. Stanley Donald Stookey, a research chemist working for the North American glass company Corning Inc., accidently over-heated a batch of lithium-containing glass, turning it a milky-white colour. Thinking that his experiment had failed he took it out of the furnace, but as he did so it slipped and fell on to the hard floor. But nothing happened; the glass did not shatter.

Stookey realised that adding lithium to glass reduced its thermal expansion and through subsequent tests he was able to demonstrate that with the right amount of lithium added, glass could be used in extreme temperature variations without cracking. Corning trademarked it and in 1958 launched a range of kitchenware under the brand name of CorningWare. Suddenly it

The aerospace industry relies on navigation systems with accelerometers and gyroscopes made from lithium glass-ceramics. *(Image: Shutterstock)*

became possible to take a dish of food straight from the freezer to the oven and sales soared. Over the next 50 years several hundred million pieces were sold.

Why lithium?

Lithium-containing glass-ceramics contain a base of lithium-aluminosilicate (LAS), with small additions of other elements added to give specific properties for certain applications.

Lithium is needed to form the special crystalline phases whose negative thermal expansion balances the positive expansion of the glass phase. This gives the glass-ceramic its low or near-zero thermal expansion.

At SCHOTT these important properties are applied to many products, from CERAN® cooktop panels and ROBAX® fire viewing panels to mirror substrates for astronomical telescopes made of ZERODUR® glass-ceramic, PYRAN® Platinum fire-resistant glass or NEXTREMA® for technical applications.

Case study: ZERODUR®

Today lithium-bearing glass-ceramics can be found in many applications where a minimal thermal expansion is essential, as illustrated by a case study of SCHOTT's ZERODUR® material.

ZERODUR® is a glass-ceramic with near-zero coefficient of thermal expansion (CTE) over a wide temperature range. According to SCHOTT, approximately 70 to 78% of its weight is nano-crystallites of 30 to 50 nanometres in size, embedded in a glassy matrix, with the size and number of the nano-crystallites adjusted to achieve an extremely low thermal expansion.

This extraordinary property means that applications requiring the highest precision can avoid geometrical shape and distance changes between parts even when exposed to temperature variances.

For over 50 years, SCHOTT has produced ZERODUR® glass-ceramic at its headquarters in Mainz, Germany, using a two-step process: First, the carefully selected raw materials are melted, cast into moulds, and annealed to obtain the glass phase. Second, a precise ceramization process transforms this glass phase into ZERODUR® glass-ceramic through controlled growth of nanocrystals.

The negative linear thermal expansion coefficient of these crystals compensates for the positive expansion of the remaining glass phase. The high homogeneity and internal quality of ZERODUR® can be attributed to the well-established melting and ceramization processes.

• For aircraft

The aerospace industry relies on navigation systems with accelerometers and gyroscopes

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ZERODUR® mirror substrates for space optics are lightened using precision grinding to remove up to 90% of the original casting, while maintaining the strength needed to survive the launch and in harsh space environments. *(Image: SCHOTT)*

continued from page 5

that measure the linear acceleration and angular velocity in all three directions (x, y, z) to determine an aircraft's exact velocity and position. The integration of these instruments is vital for the complex manoeuvres and navigation required in modern aviation.

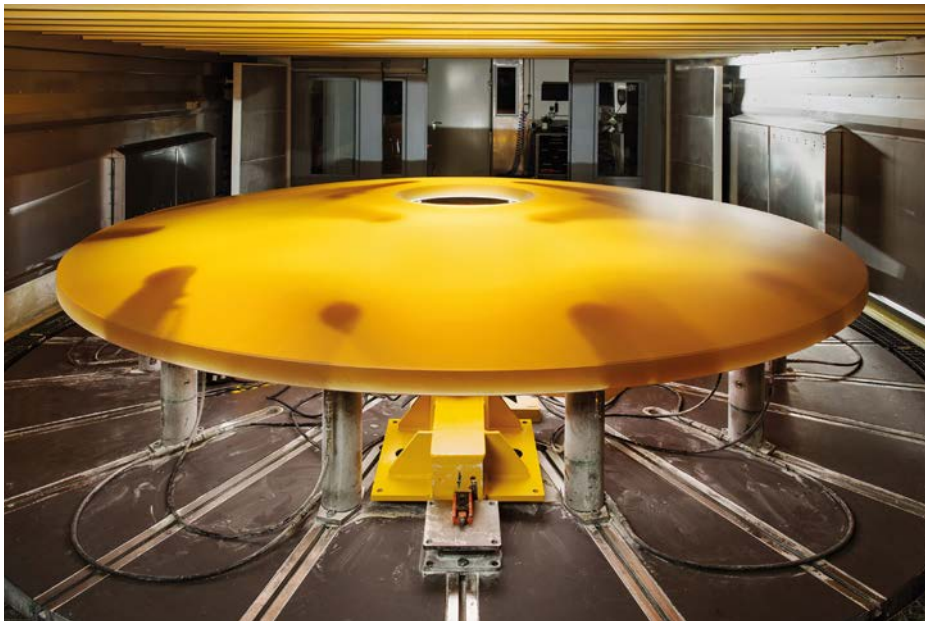
One type of gyroscope technology makes use of the Sagnac effect, which describes the occurrence of a phase shift between two light beams travelling under rotation along a closed loop in opposite directions. This ring laser gyroscope is made from ZERODUR® glass-ceramic: the entire laser beamline is operated in a block of ZERODUR® called the body of the gyroscope. For the beamline control, ZERODUR® serves as substrate material for the highly reflective mirrors and a prism that is part of the detector optic.

Relying on ZERODUR® glass-ceramic with its low CTE results in an extraordinarily consistent beamline length. Furthermore, the glass-ceramic has a very low helium permeability, preventing the out-gassing of helium, which serves as a lasing medium. Both properties combined enable extremely precise position measurements and a very long operating life for ring laser gyroscopes. Gyroscopes that use ZERODUR® on board aircraft will travel approximately 4,700 times the distance of the Earth's circumference every day.

• For giant telescopes

Astronomy seeks to reveal the secrets of our universe. Observing at different wavelengths as far back as a few moments after the big bang, astronomers collect data to support, challenge, and certainly improve our current physics model basis to understand our universe.

To accomplish that, astronomers need powerful telescopes that count as some of the most



A 4-m-class ZERODUR® secondary mirror substrate created for the Extremely Large Telescope in Chile. *(Image: SCHOTT)*

sophisticated machines humans have ever built. Key to observing astronomical objects in deep space is collecting enough photons and avoiding or mitigating image disturbances from Earth's atmosphere. For this reason, the telescope design with its materials, components, and detectors needs to support large and precisely aligned apertures so that they do not lose any photons during observation. Since air temperatures change throughout the night it is essential to have extreme thermal stability for the optics, especially the mirrors.

To overcome these challenges, ZERODUR® glass-ceramic was selected as mirror substrate for the Calar Alto Observatory in Spain, even though the glass-ceramic had developed just a few years earlier. The near-zero thermal expansion of its tiny samples convinced the astronomers at the Max Planck Institute of Astronomy in Heidelberg to choose this new material. Their order of 12 blanks from 0.3 m to 3.6 m in diameter is considered as the day of the commercialization of the glass-ceramic ZERODUR®.

Today ZERODUR® glass-ceramic is still the mirror substrate material of choice for many ground-based stellar and solar observatories, including the Gran Telescopio Canarias in Spain, Keck Observatory telescopes in Hawaii, and flying NASA telescope SOFIA. The largest ZERODUR® blanks ever made – measuring 8 m in diameter – serve as the primary mirrors of European Southern Observatory's (ESO) Very Large Telescope (VLT) situated on Cerro Paranal, an 8,645-foot-high (2,635 m) mountain in Chile's Atacama Desert.

Similarly, for ESO's Extremely Large Telescope (ELT), currently under construction in Chile, SCHOTTproduced 949 mirror substrate blanks in series. ELT will have a 39-metre main mirror and will be able to collect 100 million times more light than a human eye. When it starts operation in 2030 it will be the largest visible and infrared light telescope in the world.

• For satellites

Observatory satellites need their optics to be as light as possible, able to survive launch and mechanically stable to create high-resolution images.

Whether observing the Earth or deep space, they need picometer stability and many, including the

Hubble Space Telescope, use ZERODUR® to achieve this goal.

This thermal stability needs to be maintained throughout the orbit's trajectory, which induces thermal gradients on the optics. Mirror substrates constructed using ZERODUR® exhibit near-zero thermal expansion over a wide temperature range that can be tailored to a space mission's operational temperature.

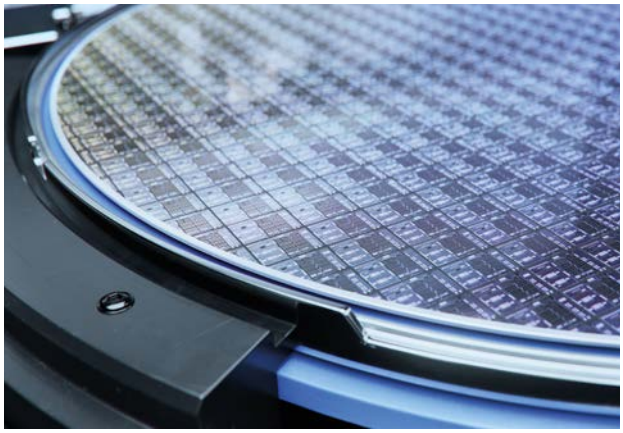
• For microchips

Microchips are essential to computers. Although microchips have not increased in size, the number of transistors on chips have increased by a factor of 1000 over the past two decades in line with Moore's Law.

Improved chip performance is a result of higher transistor densities, achieved by finer structures down to nanometer sizes. To realize this, a sophisticated positioning system needs to align the microchip substrates, i.e., wafers, with respect to the photo mask blank to provide the structure information with nanometer precision and accuracy.

Materials used in this and other systems in semi-conductor lithography require extreme thermal stability to support precise alignment and consistency. The extremely small structures of modern integrated circuits in computers and smartphones are produced using ZERODUR® glass-ceramic components.

With its near-zero thermal expansion, ZERODUR® is the material of choice to support positioning systems and help photolithography machines to accurately position the wafers for exposure.



Manufacturing silicon computer chips requires extreme precision.
(Image: Shutterstock)

• For displays

Flat panel displays are produced using similar methods to those used in microchip production. This requires large optics that allow for increased pixel density while reducing the pixel pitch to close to one micrometer.

Large ZERODUR® substrates can be found in the vast majority of flat panel display lithography devices thanks to the glass-ceramic's low CTE over its entire volume and its excellent polishability.

This is because its extremely low thermal expansion and excellent polishing properties make it an optimal mirror substrate material in these optics.

The Extremely Large Telescope under construction in Chile.
(Image: C. Letelier/ESO)

• For measurements

In the manufacturing industry, reliable production processes and high throughputs of the highest quality are required. Precise metrology (the science of measurement) is essential to precisely align products on the production line during each processing step or during quality checks and iterative manufacturing.

Alignment systems can be as simple as scale bars with sophisticated encoding systems to position products to micro- and nanometer precision. At such low margins, the thermal expansion of the alignment systems influences its accuracy if temperature gradients cannot fully be avoided. Therefore, rulers made from ZERODUR® allow for high-precision positioning within the nanometer range due to its near-zero thermal expansion over large temperature ranges (0°C–50°C).

What is next for glass-ceramics?

Lithium aluminosilicate (LAS) glass-ceramics are already a relatively mature materials family. The future for these remarkable substances is likely to focus on applications where precision is at a premium, rather than becoming a mass-market product.

Its use is likely to evolve through smarter compositions, tougher microstructures, and new manufacturing techniques in the future, but one thing seems certain: wherever dimensional stability under extreme conditions is non-negotiable, the material of choice will remain lithium aluminosilicate glass-ceramics.

ILiA wishes to sincerely thank SCHOTT for its collaboration and support for this article. For further information about ZERODUR® visit https://www.schott.com/de-de/products/zerodur-p1000269/downloads

Feature

LITHIUM FROM CLAY: AN INTRODUCTION

By Ivan Castano & ILiA

The landscape close to the Thacker Pass Lithium mining area.

Roughly 16 million years ago, a super-volcano on the Nevada-Oregon border in western USA erupted on a massive scale, before collapsing in on itself, forming what is now called the McDermitt Caldera. Fortunately for us, today the volcano is extinct - the hotspot which created it is currently underneath the Yellowstone Plateau – and the crater it left behind contains a vast deposit of lithium-enriched clay, which several companies hope to soon start commercially extracting.

Clays are an emerging and commercially untested source of lithium which aim to rival the much more prevalent hard-rock and brine deposits accounting for the bulk of the world's lithium production.

Today the most advanced lithium-clay mining projects are concentrated in the western US where companies like Lithium Americas, Jindalee Lithium, Aurora Lithium and Chariot Corporation are rushing to extract the silver-grey metal from calderas. These developments are happening as the Trump administration in Washington DC looks to promote US domestic lithium production and thereby curb its dependence on imported raw materials.

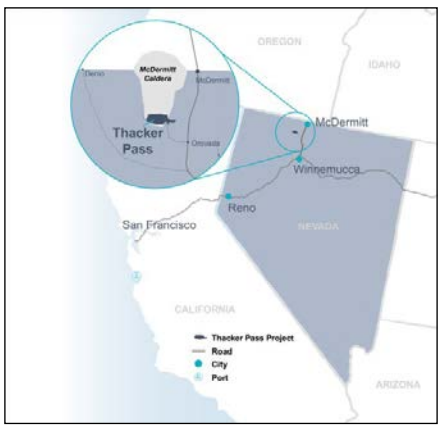
Other clay deposits exist beyond Nevada, notably in Mexico's Sonora State, which is said to contain 1.7m tonnes of the mineral. China is also understood to harbour claystone in its southwestern and south-central regions, but its resources are still being fully quantified.

The leading venture in the USA, Lithium Americas' Thacker Pass project, is planning to produce 40,000 tonnes of 'battery grade' lithium carbonate by late 2027, thanks in part to a USD2.26 billion loan from the US Department of Energy. It will take several years for McDermitt to reach its full potential as stakeholders are still working to understand the area's geological composition.

Where are clays found?

Unlike hard rock and salt brines, clay is primarily found in sedimentary basins linked to past volcanic activity. The mineral comes in myriad colours (in McDermitt, the dominant hue is dark grey or sometimes a pale green/bluish grey. It turns brown, tan or reddish-brown when oxidized). It is extremely fine (<0.0002mm), and comes in flat, plate-like sheet silicates.

When mixed with water, clay becomes highly malleable, though it has low water permeability so injecting water into its structure is a big challenge.



A map showing the location of Thacker Pass in western USA.

(Image: Lithium Americas)

During the volcanic event, hot lithium and fluorine-bearing hydrothermal fluids interacted and altered the area's sediments, such as ash tuffs (rock), to create lithium-rich illite clay. This process occurred over millions of years.

Simultaneously, clay accumulation also stemmed from weathering and lacustrine precipitation from a lake that formed after the eruption.

The mechanism involved low-temperature bedrock weathering or direct precipitation and diagenesis (physical and chemical changes) of fine-grained deposits containing lithium-bearing ash and glass that spewed from the volcano.

The result was a magnesium smectite but with great thickness, at least at McDermitt and its vicinity, which makes it more commercially appealing than elsewhere.

An advantage of the U.S. smectite deposits is that "you can have a couple of hundred feet of thickness, with little overburden, in a confined footprint whereas in many other places you just get one-inch-thick clay layer," said Dr Day-Stirrat.

Extraction methods

In clay deposits, the lithium is chemically bound to its structure, making it harder to separate and produce at a commercial scale.

(Image: Getty Images)

Consequently, firms are actively developing and testing various extraction methods.

At Thacker Pass, the focus is on mining illite through conventional, open-pit techniques. The ore is removed, crushed into a slurry and then mixed with sulfuric acid and heated in vats. The acid dissolves the mineral into a liquid solution or 'leach' that releases the lithium. This method also helps eliminate impurities (like iron and/or aluminium) from the process.

Ehsan Vahidi, a researcher at the Department of Mining and Metallurgical Engineering at the University of Nevada, Reno, explained to *The Lithium Voice* that Thacker Pass and the other Nevada projects make their own sulfuric acid and use heat emitted from the 'exothermic' chemical process to generate their own electricity.

Producers are also striving to recycle as much water as possible - particularly from leaching. "At the end of the process, when they separate the lithium from the water, the goal is to recycle the acidic solution into the [leaching] tank and therefore use less water," Vahidi added.

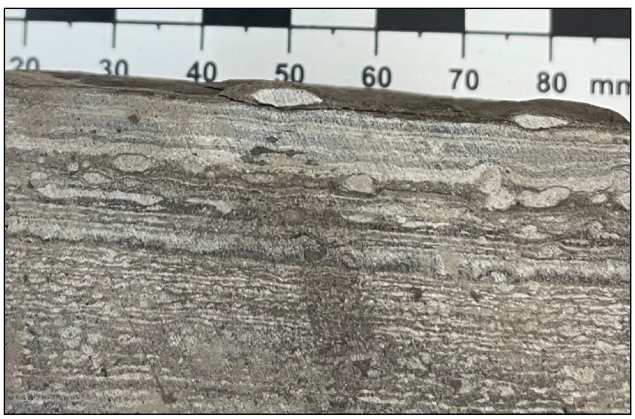
Production challenges

As the US lithium industry scales up, it is investigating in new and more efficient ways to mine lithium.

Dr Day-Stirrat said Jindalee is testing different approaches to show it can efficiently make the metal from smectite deposits to win government permits to build its future facilities. One challenge is ensuring that the ore grade is of the highest possible quality, free of "waste rock" such as aluminium silicates, before taken to the processing plant.

Geologists expect smectites will be easier to process than illites, despite having a lower lithium concentration. This is because the former dissolve more easily to release lithium. The latter, however, can be embedded in a more resilient mineral structure.

"There is a trade off from one mineral to the other," according to Day-Stirrat. "At Thacker Pass, illite has approximately 4,000 parts per million (ppm) of lithium concentration while smectites at McDermitt have roughly 2,500 ppm."



A bisected core sample from a clay deposit showing layers .

(Image: Lithium Americas)

Illite clay structures must be further researched to reduce their processing's chemical consumption.

"The lithium can be sitting on the surface of the clay or inside it, bound with the structure and requiring a lot of sulfuric acid to separate," Vahidi noted, adding that 90% of Nevada's lithium is locked within crystal lattices.

"We need to fill the gap between geological and metallurgical engineering," he continued. "We know where the resource is and how to extract it. But we need a better understanding of the clays' mechanical properties to lower acid concentrations."

Simon Jowitt, director of the Nevada Bureau of Mines and Geology, said the industry has launched several R&D labs to gain more insight into the morphology of the country's lithium deposits.

"It's crucial to understand how these systems form from a geological basis," he told *The Lithium Voice*. "If we understand this, we can find more of them, not just in Nevada, but in Arizona and other states like California."

Sustainable production

Civil society groups have charged the McDermitt sites with potentially violating indigenous populations' access to sacred lands, impacting water and affecting birds such as Golden Eagles. Steven Emerman, head of mining and environmental consultancy Malach Consulting, said that the sector must do more to discard clay tailings or leftovers from the leaching process.

"Those tailings can be very acidic," Emerman explained, adding that miners could neutralize them by mixing them with crushed limestone. Jowitt further noted these types of environmental pressures are unlikely to go away anytime soon.

President Trump's administration appears to be eager to speed up lithium production in the US in general and at McDermitt in particular. Only time will tell how this will impact production, but according to Emerman "companies in Nevada are doing the right things, and the ones that have the best engagement with [environmental and social] issues will be the most successful."

Feature

GBA'S BATTERY PASSPORT

As demand for batteries grows, global interest in related topics such as carbon emissions, labour conditions, and the recycled content of batteries has also grown. Leading the regulations is Europe, where from 2027 batteries will need to demonstrate their carbon footprint and other key criteria in a digital 'passport'. One of the thought leaders on the subject of Battery Passports is the Global Battery Alliance (GBA), of which ILiA is a member.

Introducing the GBA

The GBA was created to address environmental, social, and governance challenges linked to the rapid adoption of battery technologies, especially those used in electric vehicles and energy storage. To do this it brings together companies, governments, civil society organisations, academics, and international industry associations, including ILiA. It was launched in 2017 at the World Economic Forum and today it has around 130 members from 30 countries, including SQM, Rio Tinto, Umicore, CATL and Tesla.

The GBA exists to help the battery industry grow in a way that is responsible, transparent, and sustainable, while still supporting the global transition to clean energy.

The GBA exists to help the battery industry grow in a way that is responsible, transparent, and sustainable, while still supporting the global transition to clean energy.

The main goal of the GBA is to build sustainable, responsible, and circular battery value chains by 2030. This means ensuring that batteries are produced with lower carbon emissions, that raw materials are sourced responsibly, that workers' rights are respected, and that batteries are designed to be reused and recycled.

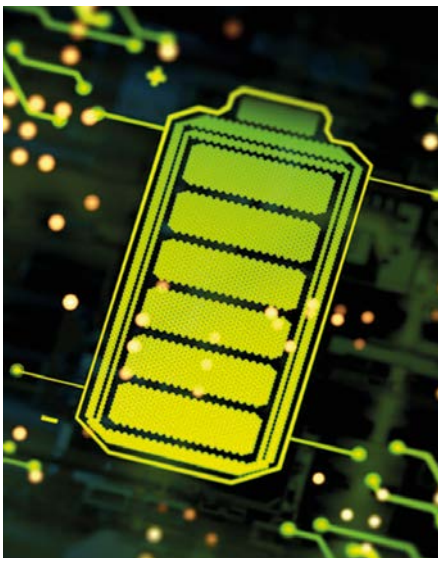
Speaking exclusively to *The Lithium Voice*, GBA's Executive Director, Inga Petersen, explained that "the GBA focuses on aligning companies and governments around common sustainability benchmarks so that expectations are clear across the entire battery supply chain, from mining through to recycling. It's about clarifying the role and expectations for each part of the value chain and the wider ecosystem including not-for-profit organisations, labour, and international organisations".

One of the GBA's most important initiatives to reach this goal is the Battery Passport.

The GBA Battery Passport

The Battery Passport[1] is an emerging product level sustainability certification scheme built on digital product passport technology that contains key sustainability information about a battery. It acts like a "digital ID" showing where materials came from, how the battery was produced, and how it performs against environmental and social criteria such as a battery's carbon footprint, whether human rights risks are managed in the supply chain, and how well the battery is designed to support the transition to circularity.

Companies across the supply chain both receive and contribute data to the Battery Passport, following a set of performance expectations known as the **Battery Benchmarks** which build on regulatory expectations, international frameworks like the OECD Due Diligence guidance and voluntary sustainability standards, ensuring compatibility and enabling comparability while protecting commercially sensitive information. The data that is submitted gets checked for quality, before being combined to create comparable sustainability indicators.



One of the goals is to allow companies, regulators, and eventually consumers to better understand (and compare) the sustainability performance of the different batteries on the market.

ILiA's Astrid Karamira represents the Association on GBA's Board of Directors and explained how ILiA's *Product Carbon Footprint Guidance* supports battery passport technologies: "ILiA's Guidance covers battery-grade lithium carbonate, lithium hydroxide, and other lithium products, so it is a key tool for battery manufacturers seeking to understand the overall carbon footprint of their products".

Delegates attending the GBA's 2025 AGM in Brussels, Belgium. *(Image: GBA)*

She added that by enabling lithium inputs to be quantified in a consistent and verified manner, the guidance helps cell manufacturers meet carbon footprint disclosure requirements under both the GBA's Battery Passport framework and the wider EU Battery Regulation, under which all batteries placed on the European market after 2027 must disclose their carbon footprint, with mandatory performance thresholds expected to be introduced at a later stage.

> ***"The GBA Battery Passport provides a framework that efficiently supports compliance with regulation"***
>
> ***Inga Petersen, GBA Executive Director***

While the GBA Battery Passport is voluntary and has a global view, it is closely linked to the EU's Battery Regulation. Under this regulation, battery passports must include information about supply chain transparency, the carbon footprint of its production, customer due diligence, and circular economy requirements such as the percentage of recycled material the battery contains.

The GBA Battery Passport is designed to align with these rules in a straightforward and practical way. In doing so it will help companies prepare for EU compliance and, in many cases, go beyond the minimum legal requirements. In this way, the GBA provides a multi-stakeholder-led framework that supports regulation rather than replacing it.

Next steps

To ensure the GBA Battery Passport works in practice, the GBA has been running operational trials since 2023. The second trial, in 2024, included 10 pilot consortia, led by battery makers representing over 80% of global electric vehicle battery market share. The latest operational trial was launched at GBA's annual membership meeting in December 2025 and will run until the end of Q2 of this year, involving 14 individual piloting consortia.

These trials test the passport system using real batteries and real supply chains and each round of testing has generated considerable improvements. Companies in trials report actual data, with digital systems being tested, and sustainability scores being produced. The trials also test how data is shared, verified, and assured. This important step will help to identify gaps, technical challenges, and better understand the costs of implementation before the passport is fully rolled out.

Subsequent additional piloting rounds may be scheduled if necessary to ensure the final version is robust, practical and fit for purpose. *The Lithium Voice* will keep you informed as this project progresses.

[1] For further information see *https://www.globalbattery.org/battery-passport/*

ILiA joined the Global Battery Alliance in July 2022 and currently sits on the Board of Directors, represented by Astrid Karamira. Other leading associations that are part of the GBA include the Nickel Institute, the Cobalt Institute, the Extractive Industries Transparency Initiative and the Responsible Business Alliance.

View from AUSTRALIA

From Irina Melkonyan of Wood MacKenzie

2025 served as a brutal stress test for the lithium industry. It was a period defined by supply contraction, particularly for assets positioned in the upper cost curve. Many Australian miners were forced to reduce production guidance or place mines into care and maintenance as prices dipped. However, the narrative shifted in the second half of the year.

After bottoming out at approximately USD7,700/t in mid-2025, prices staged a powerful recovery, rebounding 50% by December. Momentum has surged into early 2026, with spot prices continuing to climb further.

This rally was anchored by supply-side discipline and a surprising surge in battery energy storage system (BESS) demand that caught the market off-guard. For the Australian sector, this turnaround delivers vital margin relief and a restoration of free cashflow. Yet, as the dust settles, the industry faces a critical crossroads: where should this newly recovered capital be deployed?

Reinvesting in the domestic pipeline

While Australia's pipeline of advanced staged projects is limited, exploration activity is yielding good returns.

A steady flow of high-grade intercepts from junior explorers are mapping the next generation of deposit opportunities. Commitment to exploration in a period of lower prices reflects the stability that established mining jurisdictions like Western Australia provide. However, progressing greenfield projects to financial investment decisions and construction will require a sustained period of good prices.

Doubling down on downstream

The push for domestic value-add remains a central pillar of the Australian government's mineral strategy. Despite commissioning hurdles and high costs at several refineries, the government remains committed to building out domestic downstream refining. Most recently, in January 2026, the Western Australian government launched a AUD9 million grant round under the Clean Energy Future Fund to support local processing and innovative technologies including lithium chemicals.

However, Australia's operating refineries have seen first-hand the challenges in ramping up cost competitive production of lithium chemicals. And much of the technical know-how and equipment is siloed in China. Add in distances to end-consumer markets and capacity build out from key partners including Japan and South Korea, and Australian refiners may struggle to compete.

2025 also saw the emergence of a lithium chemicals intermediate market offering alternative supply chains for battery chemical production. Some argue the midstream sulphate route offers a "halfway house" that captures value without the extreme capital intensity of hydroxide plants. However, this path is also likely to face stiff competition; China maintains a considerable cost advantage and Huayou Cobalt is building sulphate capacity in Zimbabwe, where labour costs are lower.

Looking beyond borders

The final option involves investing in overseas opportunities, as many Chinese companies have done. PLS recently signalled a shift toward geographic diversification by completing its acquisition of Latin Resources at its Colina project in Brazil. PLS CEO Dale Henderson has warned that Australia risks losing its competitive edge to Brazil, citing significantly lower electricity costs of roughly 4 cents per kWh in the state of Minas Gerais, compared to 10-20 cents in the Pilbara.

Australia holds a unique first-mover advantage, having developed the technical skills and intellectual property required to bring hard-rock lithium mines online. This expertise is now a portable commodity. Whether deployed domestically or used to anchor projects in South America or Africa, this knowledge base is one of Australia's greatest assets.

A multi-pronged future

The path forward is not a binary choice. The future likely involves a considered combination of all three strategies: maintaining a robust domestic exploration pipeline, targeted downstream investment where economically viable, and the bold deployment of Australian mining expertise internationally.

The turmoil of 2025 was a painful but necessary correction that has left the sector leaner and more resilient. However, looking ahead, how the Australian lithium sector leverages its current position will play a crucial role in shaping both its own future and the broader dynamic of the lithium industry.

View from Australia represents the opinions of Wood Mackenzie and does not reflect the opinions of ILiA.
ILiA member benefits include exclusive quarterly webinars with Allan Pedersen regarding the lithium market. Contact ILiA for details.

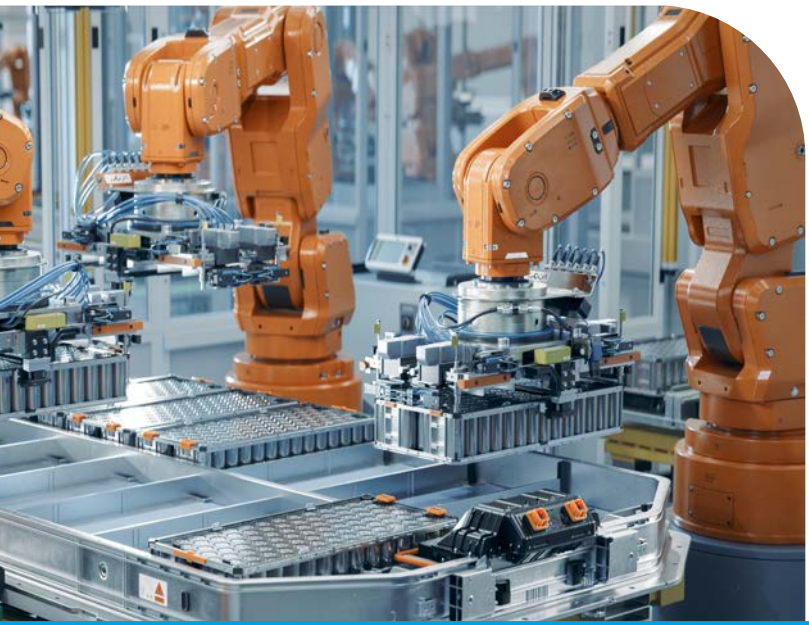
Lime: critical to lithium processing efficiency

Essential across lithium feedstock processing

Across hard-rock, clay, and brine routes, lime is integral to producing lithium carbonate and lithium hydroxide. Quicklime (CaO) is the precursor to hydrated lime ($Ca(OH)_2$), applied as a dry reagent or in slaked (milk-of-lime) form.

Key applications of lime in lithium flowsheets:

- Selective precipitation of impurities
- Conversion of lithium carbonate to lithium hydroxide
- Treatment of acid gas emissions
- Process pH control



Reliable global supply

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View from EUROPE

From Jordan Roberts of Project Blue

The European lithium market has continued to develop during the fourth quarter of 2025 and into 2026. New production facilities were commissioned, national strategies unveiled and key strategic projects received funding to begin construction.

In December 2025, Vulcan Energy Resources (Vulcan) secured one of the largest project finance packages in the lithium sector to advance the company's Phase One Lionheart project in Germany. The EUR2.2 billion package comprises institutional equity, major debt, and government grant support, fully underwriting construction of the planned 24k tpy lithium hydroxide project.

The package represents the first capital deployment from Germany's Raw Materials Fund. The involvement of the European Investment Bank and other export credit agencies alongside the German Government highlights the focus on strategic financing for critical mineral supply chains in Europe.

In December, EcoPro completed construction of its cathode production facility in Hungary, a further positive for the European battery value chain. Alongside 54k tpy of cathode material production, sufficient for around 600,000 electric vehicle batteries, the facility is also expected to produce 8k tpy of lithium hydroxide.

Several projects that have been classified as 'strategic' by the EU have provided updates on development and funding:

- Sibanye-Stillwater's Keliber lithium project remains on track to complete construction and cold commissioning of its fully integrated lithium hydroxide project in Q1 2026. The project will undertake a staged approach, focusing initially on the mining and concentrating stages before commissioning the refinery.
- Savannah Resources has secured a non-reimbursable Portuguese state grant of up to EUR110 million (USD128 million) to support development of its Barroso Lithium Project in northern Portugal. Roughly EUR82.3 million has been earmarked for capital expenditure and a further EUR27.4 million as a performance bonus payable between 2031–2042.
- Lifthium Energy has been awarded a government grant under the European Union's Temporary Crisis and Transition Framework. The EUR180 million (USD210 million) non-refundable grant will assist with developing the Lift One project toward first production of lithium chemicals, targeted for 2030.

Sibanye-Stillwater's Keliber concentrator in December 2025. *(Image: Sibanye-Stillwater)*

Meanwhile, the UK has unveiled a Critical Minerals Strategy that targets 10% of domestic supply from local production and 20% from recycling by 2035, including plans to produce at least 50k tpy LCE of lithium chemicals. The strategy also aims to cap reliance on any single foreign source at 60% to reduce exposure to countries such as China.

Imerys delivered a white paper to the European Commission, suggesting that over 20% of the lithium used in EVs should come from the EU by 2031, rising to 40% by 2036, to encourage automotive manufacturers to buy from producers inside the bloc.

Despite clear momentum across Europe's lithium ecosystem, significant headwinds remain. High capital and operating costs, slow and fragmented permitting, and ongoing reliance on imported materials continue to challenge competitiveness. At the same time, technology scale-up risks, workforce and industrial capability constraints, and less predictable downstream demand complicate execution.

As a result, many projects will depend on sustained government support, strategic partners, and long-term offtake certainty to be successful.

View from Europe represents the opinions of Project Blue and does not reflect the opinions of ILiA.
ILiA member benefits include exclusive quarterly webinars with Project Blue regarding the lithium market. Contact ILiA for details."

PROJECT BLUE

View from CHINA

From Thomas Feng of SMM Information & Technology Co., Ltd

A year-end rally amid policy expectations

In Q4 2025, China's lithium carbonate market saw prices surge strongly and then fluctuate at highs amid a mix of factors including year-end demand spikes, macro policy expectations, and persistent supply disruptions, with the quarterly average price rising significantly month-on-month (MoM).

Lithium carbonate supply-demand balance and price trends

In Q4 2025, China's spot lithium carbonate market showed a "stepwise increase" pattern. Prices rose steadily in October, up 2% MoM, reaching a high of 81,000 yuan/mt driven by stronger-than-expected demand from new energy vehicles and energy storage.

In November, prices accelerated, rising 15% MoM, as robust downstream demand pushed the market into undersupply, with bullish sentiment and capital inflows driving prices to a peak near 94,000 yuan/mt. After a pullback early in December, prices strengthened again, with the monthly average up 15% MoM. High prices dampened downstream procurement, which became more cautious, relying mainly on long-term contracts and just-in-time procurement for spot orders, pushing prices to a high near 122,000 yuan/mt

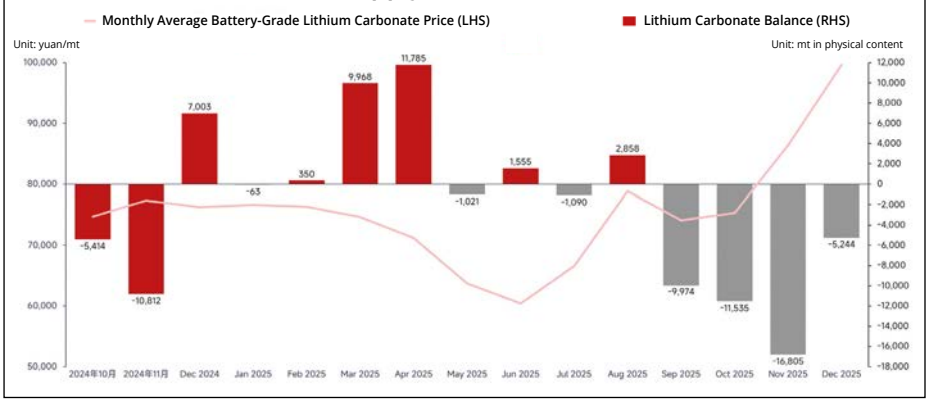
Policy adjustments: year-end policy direction and overseas developments

In the new energy vehicle (NEV) sector, Q4 policy focus shifted from short-term local subsidies to medium and long-term national planning. In November, relevant policies clarified the overall direction that "the NEV purchase tax reduction and exemption policy will continue in an optimized form after 2026," stabilizing market confidence in medium and long-term demand. In December vehicle trade-in and local consumption promotion policies were successively clarified, boosting demand for passenger NEVs.

Supply variables and inventory structure shift

In Q4 China's lithium carbonate market exhibited a robust supply-side performance characterized by steady growth, with total monthly production increasing continuously on a MoM basis.

Review of China's Monthly Average Lithium Carbonate Prices and Supply-Demand Balance



This was primarily driven by strong downstream demand, which encouraged upstream smelters to maintain high operating rates. In terms of quarterly trends, October production rose 6% MoM and surged 55% YoY, setting the tone for quarterly growth, supported by stable supply across all raw material sources. In November production increased by another 3% MoM, with all raw material ends maintaining stable supply. By December production rose approximately 4% MoM further, mainly due to the continued capacity release from new spodumene production lines, steadily enhancing overall supply capability.

Regarding inventory structure, as of month-end December, downstream material plants' days of inventories decreased compared to the beginning of Q4, as robust order conditions kept production consumption consistently high, while excessively rapid price increases during the quarter dampened spot order procurement.

Conclusion

In Q4 2025, China's medium and long-term industrial policies stabilized market confidence, while incentive measures for NEV and the energy storage systems (ESS) sector in Europe, the US, and emerging markets strengthened future demand expectations.

On the supply side, smelters maintained high operating rates stimulated by rapid price increases, leading to monthly production growth; however, slow resumption of domestic lepidolite production resulted in structural resource tightness. Overall, the quarter saw a significant upward shift in the price center.

View from China represents the opinions of SMM and does not reflect the opinions of ILiA.
ILiA member benefits include exclusive quarterly webinars with SMM regarding the Chinese lithium market. Contact ILiA for details.

View from SOUTH AMERICA

From Daniel Jiménez of iLiMarkets

The South American lithium sector recorded several notable developments over the past quarter, with meaningful progress in some jurisdictions.

In **Chile**, the joint venture between Codelco and SQM was formally approved following the final regulatory clearance, including China's antitrust authorization. This approval was granted subject to certain concessions, including minimum lithium volumes destined for the Chinese market. The newly established entity will operate under the name NovaAndino Litio.

Albemarle announced that it has achieved technical certainty for the design of its future commercial direct lithium extraction (DLE) plant in Chile. This follows the successful validation of its La Negra pilot plant, which demonstrated lithium recovery rates above 94% and water reuse of approximately 85%. These results support Albemarle's decision to proceed with the Environmental Impact Assessment (EIA).

Chile exported approximately 300 thousand metric tons (kMT) of lithium carbonate equivalent (LCE) during 2025. Looking ahead, a newly-elected, pro-business government is set to take office in March 2026. Legislative reforms aimed at accelerating project development and investment approvals are widely expected.

Argentina continues to position itself as the most dynamic lithium jurisdiction in the region. Lithium Argentina and Ganfeng released the Scoping Study for the Pozuelos–Pastos Grandes (PPG) brine project in Salta. The study confirms a scalable development strategy targeting up to 150 kMT of LCE per year, across the Pastos Grandes and Pozuelos salt flats.

Rio Tinto is also refining its lithium strategy, with the objective of reaching approximately 200 kMT LCE per year by 2028. A key focus is the expansion of its existing Argentine assets, including the Rincón project. In parallel, the company is advancing brine exploration in Chile using DLE technologies and progressing the Maricunga project in partnership with Codelco.

Among other projects, Galan Lithium's Hombre Muerto West remains on schedule. Construction activities and evaporation pond development are advancing, with first lithium chloride production expected in the first half of 2026. Additionally, Eramet and POSCO steadily increased export volumes during the quarter, while Puna Mining (Argosy) completed its first export of lithium carbonate. Overall, Argentina's lithium exports increased from 80 kMT LCE in 2024 to approximately 115 kMT LCE in 2025, reflecting the steady ramp up of new projects.

Brazil, while still expected to expand hard rock lithium production over the medium to long term, experienced operational setbacks during the period. Sigma Lithium encountered significant challenges at its Grota do Cirilo operation following a sudden change in mining contractor, reportedly intended to improve operational efficiency. Furthermore, Brazil's Ministry of Labor ordered the shutdown of three waste piles due to structural stability concerns. Sigma's appeal was rejected in January 2026, and as a result, the mine has remained inactive since October 2025. These disruptions contributed to a decline in Brazil's spodumene concentrate exports during 2025.

In **Bolivia,** the newly formed government reaffirmed its intention to honor existing lithium contracts, including those with Chinese and Russian partners. Authorities have also signaled a commitment to greater transparency and improved legal certainty to attract foreign investment. Despite these statements, Bolivia continues to lag behind neighboring countries, facing persistent technical, regulatory, and political challenges that have delayed project execution.

Regional Outlook

Total lithium exports from South America reached approximately 450 kMT LCE in 2025. Regional growth continues to be driven primarily by Argentina, as new projects move into production and exports scale up. Brazil has temporarily lost momentum due to operational disruptions, while Chile appears to be regaining strategic clarity and investment momentum. Bolivia, however, remains the least advanced lithium jurisdiction in the region.

View from South America represents the opinions of iLiMarkets and does not reflect the opinions of ILiA.

View from ASIA (outside China)

From Shiyue Zhao and Zihao Li of Fastmarkets

A 978 MW battery energy storage system in Korea belonging to Korea Electric Power Corp. *(Image: KEPCO)*

Boom in energy storage systems to drive lithium consumption as EV growth stalls.

Energy storage systems (ESS) are poised to become the main growth engine for lithium consumption in 2026, as major Asian battery makers ramp up investment in the booming sector while electric vehicle (EV) sales lose momentum.

AI and grid expansion fuel ESS surge

A rapid buildout of data centres amid the global artificial intelligence (AI) boom is driving a surge in in electricity demand. Power consumption of data centres is expected to grow about 15% annually from 2024 to 2030 — more than four times faster than total electricity demand growth across other sectors — according to the International Energy Agency. At the same time, utilities worldwide are installing large-scale energy storage systems to stabilize grids during peak loads or emergencies. Market participants expect global ESS demand to jump 50%–80% in 2026, making the sector an increasingly critical pillar for lithium and battery consumption.

Battery makers pivot to ESS amid EV headwinds

With EV sales slowing, South Korea's major battery producers are accelerating their push into ESS and expanding output of lithium iron phosphate (LFP) batteries. LFP batteries are projected to make up 89% of ESS demand in 2026, according to Fastmarkets research. LG Energy Solution said in November it will begin producing LFP batteries for ESS in 2027 at its Ochang plant, starting with 1 GWh of annual capacity. In June, the company started manufacturing grid scale storage cells for the US market at its Michigan plant, which previously produced EV batteries.

SK On signed an ESS supply deal in September with US renewable energy firm Flatiron. The company plans to begin mass producing LFP batteries in the second half of 2026 at its Georgia plant and convert 3 GWh of annual EV battery capacity at its Seosan Plant 2 to ESS output. Meanwhile, StarPlus Energy, a joint venture between Stellantis and Samsung SDI, is preparing to convert lines at its Indiana factory to produce prismatic LFP batteries this year.

"Investing in ESS is one of the strategic shifts for Asian battery makers to counter the electric vehicle slowdown," said one industry expert. "It provides a new revenue stream with more predictable growth prospects beyond traditional EV batteries."

In Japan Panasonic has been more cautious in expanding ESS capacity compared with its Korean peers, though it continues to invest in developing solid state batteries for storage applications — a technology many see as the next breakthrough for the sector.

ESS boom reshapes the lithium market

Rising ESS deployment is expected to support lithium carbonate consumption and reshape East Asia's lithium demand landscape at a time when the EV sector underperforms. South Korea imported 32,009 tons of lithium carbonate from January to November 2025, up 30% from a year earlier, according to customs data. Optimism over ESS growth has boosted market expectations for lithium demand in 2026.

The Chairman of Ganfeng Lithium, Li Liangbin, expected global battery grade lithium demand to rise 30% this year, while Tianqi Lithium's Chairman, Jiang Anqi, forecasted total lithium demand to reach 2 million tons in 2026. Fastmarkets projects global lithium demand at 1.74 million tons of lithium carbonate equivalent in 2026 — up 20% from 2025.

View from Asia (excl. China) represents the opinions of Fastmarkets and does not reflect the opinions of ILiA.

View from NORTH AMERICA

From Adriana Carvalho, Associate Director, Metals Pricing, Americas, S&P Global Commodity Insights

The successful launch of Tesla's Texas lithium refinery in early January is reshaping investor perceptions regarding the feasibility of reviving critical mineral processing in North America.

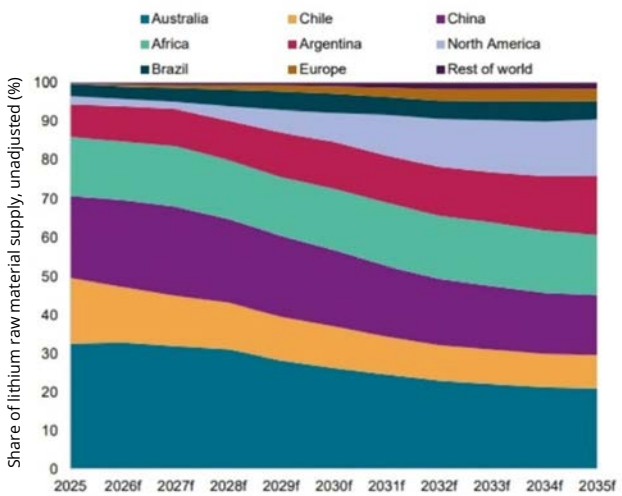
Tesla's achievements indicate that technological advancements can help bridge the historical cost gap. Additionally, Lilac Solutions and Traxys North America have announced a binding 10-year offtake agreement for lithium carbonate from Lilac's Great Salt Lake facility in Utah. This agreement is a significant step toward advancing the project toward construction and establishes a commercial pathway for a domestic lithium initiative in the US.

These developments, coupled with rising lithium prices across all regions, including the US, are contributing to a shift in market psychology that may accelerate investments in North American processing projects.

Tesla's refinery has eliminated the 6-to 8-week shipping time associated with sourcing lithium from Asian refineries, reducing transportation costs by at least USD900/mt, according to market participants. These logistical improvements enable just-in-time manufacturing approaches for North American battery producers. However, achieving regional self-sufficiency will require 8 to 10 additional facilities of comparable scale.

The Lilac-Traxys agreement includes the purchase of 50,000 mt of lithium carbonate over the decade, representing 100% of the planned Phase 1 production capacity, in 2027. This take-or-pay agreement features pricing mechanisms linked to market indices. The Great Salt Lake Phase 1 facility is designed to produce 5,000 mt/year of battery-grade lithium carbonate, nearly doubling current US production levels.

Lithium extraction to become more diversified



Source: S&P Global Commodity Insights.

The project utilizes Lilac's Generation 5 ion exchange direct lithium extraction (DLE) technology, which achieved 87% lithium recovery from the lake's ultra-low-grade brine (69 mg/L lithium) during pilot operations completed in 2025. The facility will use ion exchange media (IXM) produced at Lilac's Fernley, Nevada location.

The Fernley facility is part of the Nevada Tech Hub's "Lithium Loop" initiative, connecting US mining, extraction, and processing technology with domestic battery production and recycling.

Most commercial DLE technologies rely on media manufactured in China, exposing lithium projects to supply chain vulnerabilities highlighted by recent Chinese export restrictions on battery materials and processing technology.

Exploration spending trends

Canada remained the global leader in mining exploration in 2025, despite a notable decrease in budgets for the third consecutive year. Exploration budgets declined by 5.9% year-over-year, primarily due to a 41% drop in lithium exploration spending. This contraction occurred in an environment where metal prices for other commodities such as gold, copper, and silver increased, complicating the narrative around lithium.

The number of actively exploring companies in Canada fell 7%, from 683 to 633, reflecting a cautious sentiment toward the exploration industry. While copper investments increased by 6%, underscoring its role in electrification, lithium declined due to a market recalibration following oversupply and falling prices in the past years. The trajectory of exploration spending will likely influence North America's mineral landscape in the coming years.

View from North America represents the opinions of S&P Global Commodity Insights and does not reflect the opinions of ILiA.

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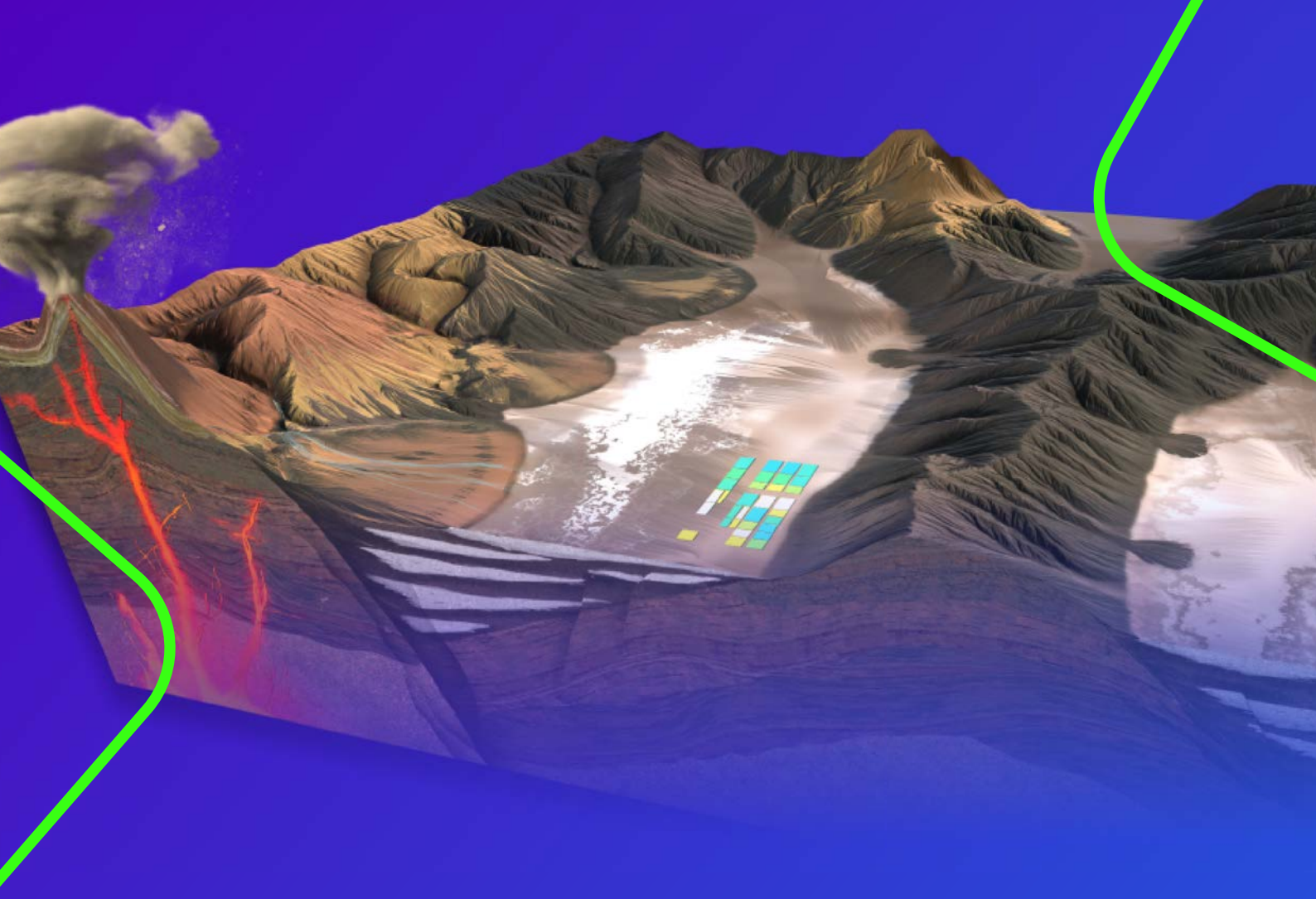

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SEE THINGS DIFFERENTLY

VIRIDIEN

In conversation with DR. HERNÁN CÁCERES

Executive Director National Institute for Lithium and Salars (Instituto Nacional de Litio y Salares – INLiSa)

Can you tell us how you first became involved with lithium?

For me, lithium has always been more than a topic of global attention; it has been part of my territory and my trajectory.

I was born and raised in Antofagasta, in northern Chile — and I also studied there. For people from the region, lithium has long been part of the local landscape, long before it became a global subject of attention. In my case, the connection was even more direct: my father worked in the industry, so I grew up hearing about projects, challenges and how the sector was evolving.

At university I studied engineering –my thesis was on lithium production – and after a PhD in the United States I settled back in Chile, in Antofagasta specifically.

How did you come to lead INLiSa?

When I returned from the US, I worked at the Universidad Católica del Norte and lithium was often a key focus of my work, although not the only one.

In 2022 I was tasked with creating a research center focused on the lithium battery value chain. This was a success and grew into one of the most relevant R&D efforts in northern Chile. This experience gave me a broad view of how science, industry and territory interact and helped me understand lithium not only as a material or a technology challenge, but as a territorial story involving science, industry and people.

INLiSa was established to foster sustainable lithium production, protect ecosystems, and advance technology in the Salar region of Chile and I was asked to lead it. Today, we are just over one year old.

What innovations do you see as most promising for the future of the lithium industry?

To me, the most interesting development is that the field is no longer looking for a single "winner" technology — at least not in Chile. There was a moment when many expected one breakthrough to reshape the sector, but what we are actually seeing is the emergence of a multi-technology ecosystem, where different solutions are adapted to specific brine chemistries and environmental conditions.

In Chile, that makes intuitive sense. Salars are heterogeneous systems — chemically, hydrologically, and ecologically — so innovation has to adapt to the territory rather than vice versa.

Direct lithium extraction (DLE) technologies stand out in this context. Not because it is a monolithic solution, but precisely because it is a family of approaches that could increase recovery rates, flexibility, and sustainability. The challenge — and the opportunity — is that these technologies must be validated under real-world conditions, where brine composition, reinjection, and environmental variables matter.

However, DLE alone does not solve everything and scaling is a major challenge. A gradual and hybrid transition — rather than a sudden shift from evaporation to a single DLE technology — seems more realistic.

Chile's Minister of Science, Aisén Etcheverry, and Minister of Mines, Aurora Williams, attended the launch of the National Institute for Lithium and Salars (INLiSa) that was held at the historic Melbourne Clark Pier in Antofagasta. INLiSa marks a key milestone in the implementation of the National Lithium Strategy. *(Image: INLiSa)*

Lagunas Escondidas de Baltinache, Salar de Atacama, Antofagasta region, Chile. *(Image: INLiSa)*

How do you see environmental, social and governance (ESG) standards evolving in Chile's lithium industry?

For me, ESG in lithium is no longer only a matter of environmental compliance — it is becoming a strategic question about how to create value that is compatible with territory, culture and long-term ecological resilience.

In Chile, ESG has been part of the reality from the beginning. Our salars are inhabited territories, with Indigenous communities whose history and identity are tied to the landscape. That already sets a different baseline compared to mining sectors that operate in more isolated environments. Chile's adherence to ILO Convention 169 later formalized that relationship through consultation and participation mechanisms.

The recent update to the Environmental Impact Assessment guidelines for lithium projects, introduced in late 2025, reflects that shift by integrating climate variables, wetland protection and broader ecosystem considerations.

What is INLiSa's mission, and how is it structured to connect science, industry, and communities?

The Institute was created to generate, apply and share knowledge and technology so that the lithium value chain can develop sustainably - and equally important - so that the economic, environmental and social value of Chile's salars can be managed responsibly over the long term. I like that framing because it recognizes that salars are not only mineral deposits; they are ecosystems and cultural landscapes.

The governance structure is rather innovative, including the ministries of Science, Mining and Environment, along with CORFO, regional governments and Indigenous representation. A decade ago, it would have been hard to imagine such a diverse set of actors sitting at the same table with equal institutional voice!

The goal is to produce shared and transparent information that reduces uncertainty and builds trust among all actors. In strategic sectors like lithium, transparency and trust are not just political concepts; they are part of the industrial and technological problem. Without them, it is very hard to scale innovation, investment or sustainability.

Why was INLiSa established as a public-interest, non-profit corporation rather than a traditional government agency?

This was done deliberately because lithium is a strategic sector, and also a highly dynamic one from a technological and territorial standpoint. A conventional public agency would have struggled with the speed, flexibility and international collaboration that the field requires.

In addition, this structure helps fill a coordination gap between scientists, regulators, companies, regional governments and Indigenous communities — each of which has different time horizons, incentives and information.

Speaking with each group and coordinating between them would be very difficult to achieve from a purely governmental logic or from a purely market logic. Lithium sits somewhere in between, and so does INLiSa.

How will INLiSa engage with Indigenous and local communities in the salares regions?

In lithium, engagement with Indigenous and local communities is not a parallel agenda; it is part of the coordination the sector needs. Salars are inhabited territories, and understanding those territories requires not only science and technology, but also cultural and social knowledge.

INLiSa was created with Indigenous representation on its board, which is an institutional innovation in the sector. We have identified more than 150 communities linked to the 70 saline systems across the four northern regions of Chile, and we are mandated to conduct a participatory process with them to define how their representative will be selected and how the role will be exercised. That process matters because it focuses on rules, expectations and long-term legitimacy rather than symbolic gestures.

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How do you envision INLiSa contributing to the development or assessment of direct lithium extraction (DLE) technologies in Chile?

DLE is a family of technologies, and scaling them requires validation under real-world conditions. Laboratory success is not enough; you need to test selectivity, kinetics, brine variability, energy and water requirements, and what happens with the spent brine once the lithium is removed. That is where INLiSa can contribute.

One of our mandates is to develop a piloting and validation platform in Chile with access to real brines. For DLE and other processing technologies, this is essential because most of the risk lies between TRL 5 and 8, where the industry needs evidence, not assumptions. If we can reduce that uncertainty, we can accelerate innovation and investment.

The platform is designed to be open. It is not for INLiSa alone. Our aim is for developers, companies and research centers — Chilean or international — to use it to test and validate their technologies. We want Chile to host part of the technological frontier of lithium, and that requires infrastructure that is pre-competitive, neutral and accessible.

Participating in a traditional Pago a la Tierra ceremony during the closure of the Indigenous consultation process for the CEOL (Special Lithium Operating Contract), the Chilean state instrument authorizing lithium development under defined technical, environmental, and social conditions, in the Ascotán and Ollagüe salars (24 September 2025). *(Image: INLiSa)*

From my perspective, the contribution is twofold: technical and institutional. Technically, INLiSa can provide shared infrastructure, data and testing conditions. Institutionally, it can build a common language between science, companies and regulators so that Chile can move from experimentation to deployment with transparency and predictability.

In the end, if Chile wants to host the scaling of next-generation lithium technologies, it needs a place where technology, brines, regulation and knowledge can meet. That is the role we want INLiSa to play.

Do you drive an electric vehicle?

I don't own a car to move around the city. I use public transport which in Antofagasta is often an electric bus.

Santiago did it earlier and now has the largest electric bus fleet in the world outside China, and Antofagasta is now following the same path.

Seeing electric buses in Chile makes the value chain tangible: lithium leaves our salars as a chemical and returns as mobility, lower emissions and better air quality for the city.

At the same time, it highlights a gap and an opportunity. Much of the value added in the lithium chain is still generated outside Chile. One of INLiSa's ambitions is to help increase Chile's participation in that value chain — not by replacing industry, but by enabling knowledge, technology and coordination so that more of the transformation can happen in the country. Closing that gap will take time, but it is a direction worth pursuing.

Salar de Aguas Calientes Norte, Antofagasta region, Chile. *(Image: INLiSa)*

SPOTLIGHT ON SUSTAINABILITY

Mercedes-Benz shares its expectations for suppliers

Discussions about responsible sourcing and compliance with mining standards and regulations have been going on for more than a decade and during this time awareness in all parts of the value chain has increased. Yet, the focus remains on the upstream, with responsibility largely placed on mining and refining companies.

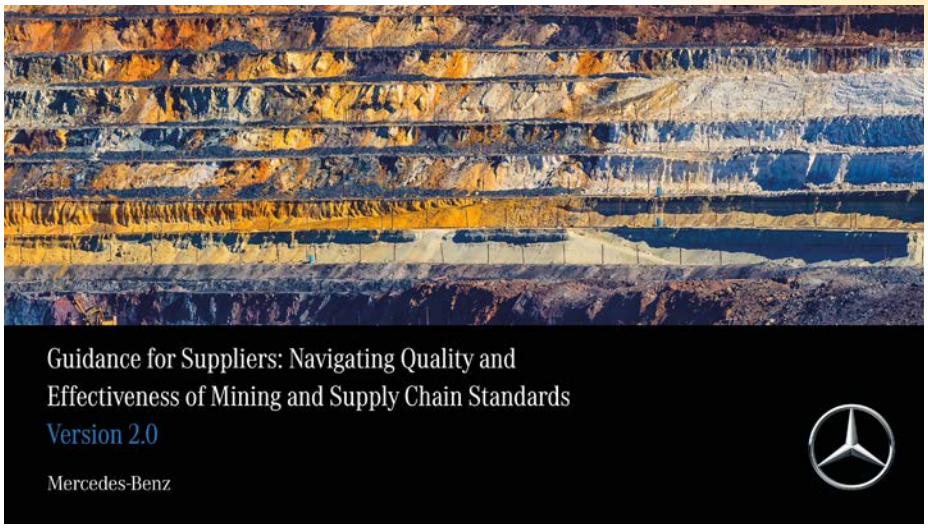

Image: © Mercedes-Benz

Lithium has traditionally been produced in OECD countries at industrial sites to very high standards. As such it has not been the focus of these standards for a long time. However, with an increasing amount of lithium miners implementing global mining standards, we wanted to know what downstream companies expect from lithium suppliers regarding ESG and sustainability performance. Looking for an answer, we spoke with Johannes Danz, Project Coordinator for Raw Materials and Human Rights, at the prominent German car-maker, Mercedes-Benz.

In their ***Guidance for Suppliers: Navigating Quality and Effectiveness of Mining and Supply Chain Standards***[1] Mercedes-Benz outlines the strengths and weaknesses of mining standards and guidelines. Asked why Mercedes-Benz created this guidance, Danz explained to *The Lithium Voice* that "it started out as an internal exercise, as we were approached by mining companies who were implementing different standards and our management wanted to better understand the different risk levels."

Danz added that, "as a globally diversified company, Mercedes-Benz lacks direct control of the risks in their supply chain beyond their Tier 1 suppliers as they normally do not source raw materials directly and Human Rights risks are often the most severe where they have the least influence, namely in the mines and extraction areas at the start of the supply chains - and without contractual relationships, they have no legal means of influence."

For example, one topic was contacting affected communities that were adjacent to mining areas. Danz is based in Germany, far from the major sources of global lithium production, and he found that working with international mining standards greatly helped him to positively influence this aspect. "Standards are much more than a certification. They are rather an instrument to get in touch with mining-affected communities and with risks in our supply chain, to better understand what is happening in the upstream and on the ground", Danz explained. This is a key facilitator for the company's risk management policy.

In a recent fireside chat with ILiA members, Danz was asked what advice a large OEM gives upstream companies and especially mid-tier lithium miners who are trying to decide what to do in this regard? What are a typical major carmaker's expectations?

"I often think there is a misperception regarding our expectations", Danz points out. "Mining companies do not need to outperform necessarily from the beginning. It is more important that they show progress and transparency. What is relevant to us is that miners improve their sustainability performance over time. Our preference is that mining companies go through audits and become part of the system in a way that is transparent and shows progress."

[1] https://supplier.mercedes-benz.com/docs/DOC-3223

Image: Shutterstock

ILiA Connections

In November ILiA and the China Nonferrous Metals Industry Association (CNIA) signed a memorandum of understanding. CNIA's Vice President, Duan Debing, Chaired the ceremony, and said it was important to collaborate for shared development and to promote ESG.

At the start of the year ILiA's Jorge Mora and INLiSa's Dr Hernán Cáceres visited SQM's lithium plant in Antofagasta, Chile. This plant is the largest lithium refinery in the world.

Lithium from brine plays a major role in our industry. In January ILiA's Jorge Mora joined a delegation of European politicians visiting Albemarle's plant in Salar de Atacama, Chile, to witness lithium production first hand.

At the 2025 China International Lithium Conference in Chengdu, China, Roland Chavasse gave a presentation about ILiA's members and its work to develop Product Carbon Footprint Guidance for lithium products.

ILiA hosts regular networking dinners around the world to promote connections between members. In December we held a dinner in London, UK, to coincide with the Resourcing Tomorrow conference.

In November ILiA's Martin Ma, Danyi Feng and Roland Chavasse had the pleasure to visit Tyeeli's refinery in Meishan City, Sichuan Province, China. Our thanks to Jason Qiu, Kevin Huang, April Li and Ethan Zhang!