COMPLETE GEOCHEMICAL ASSAY SERVICES
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MSALABS

Technical Document - Lithium

3
Li
Lithium
6.941

Lithium is the lightest metal in the periodic table with a specific gravity of just 0.534. It does not occur as a metal in nature.

Lithium has a very high electrochemical potential making it ideal for use in batteries.

In fact, Li ion batteries have 6 times the energy density, can be charged faster and last longer than traditional chemistries making possible a revolution in mobile power source applications. In 2014, Tesla broke ground on the largest Li ion battery factory in the world, with a name plate production capacity equal to global production at the time of commissioning.

The sheer scale of this project has spurred a significant increase in exploration activity focused on expanding the global supply of this important commodity element.

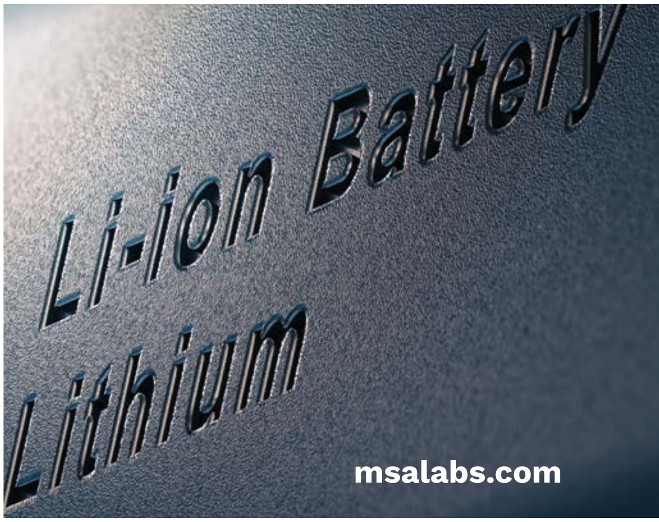
PROPERTIES AND USES

Li has a long history of commercial use that ranges from pharmaceuticals, to the production of high-tech aeronautical alloys.

Its high specific heat makes it a common component of high temperature lubricants and when combined with Chloride to form a salt, is so hygroscopic that it is commonly used as an industrial drying agent.

Lithium has also been more recently used in Li ion batteries in various power source and storage applications.

Economically recoverable lithium is rare and generally falls into three deposit types



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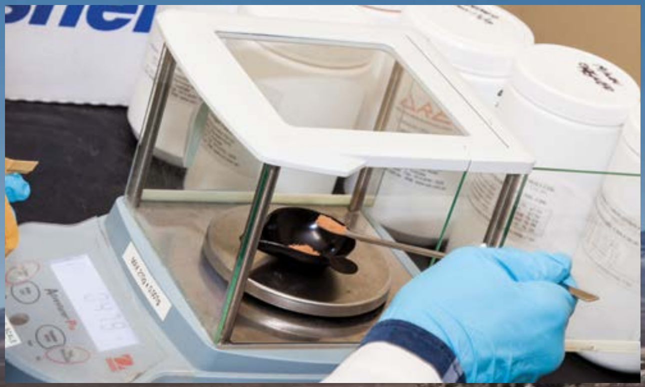

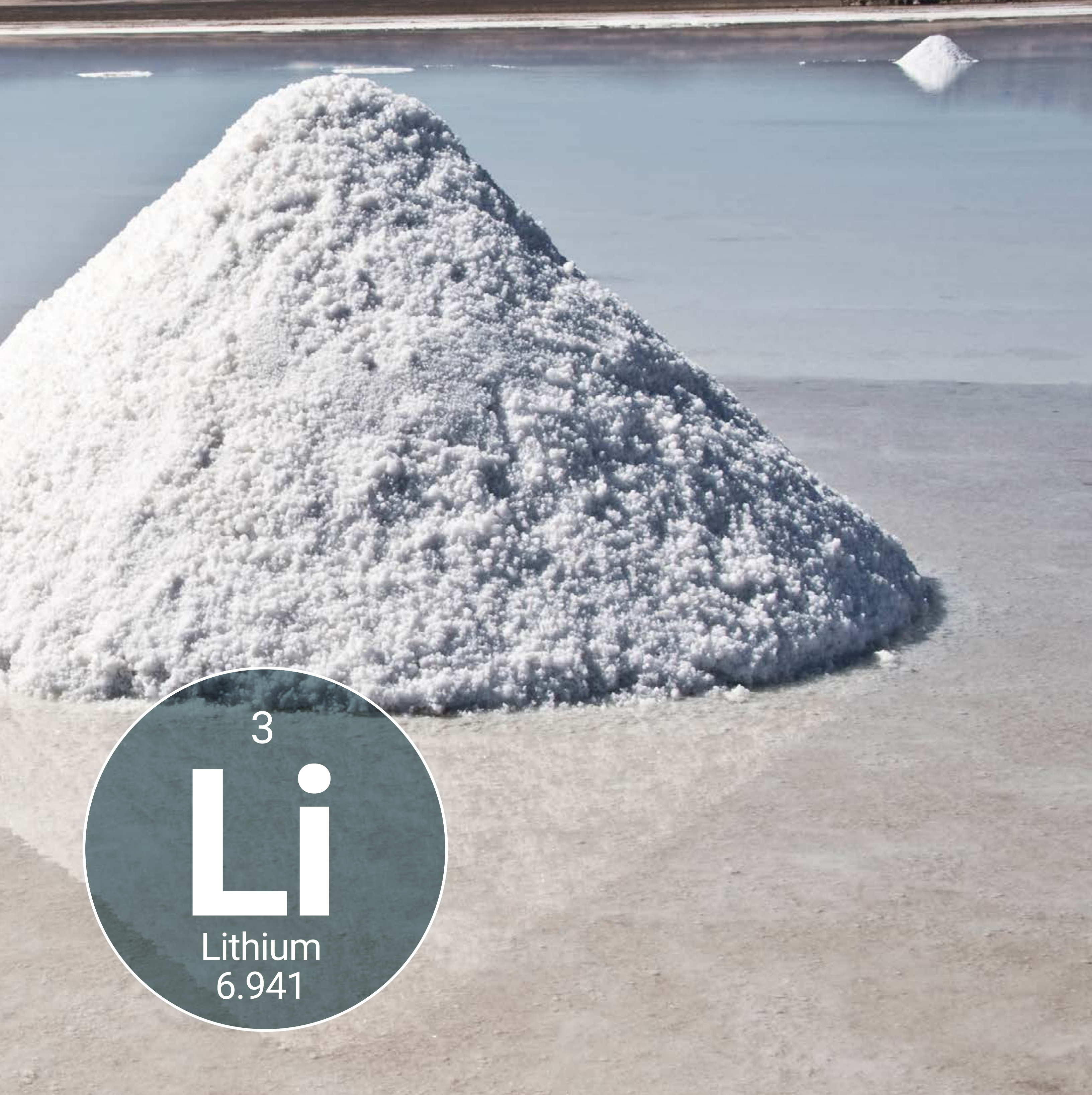
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TYPES OF OCCURRENCE AND RECOMMENDED ANALYTICAL METHODS

While Li is common at trace levels, economically recoverable Li is rare and generally falls into 3 broad deposit types.

Li BRINES

Most of the World's Li production occurs from Salars in the high deserts of Chile where Li rich continental brines are concentrated by evaporation at surface. Li is hosted in the brine solution itself, as well as a variety of evaporite minerals including sulphates, phosphates and carbonates. MSALABS recommends the following methods for the analysis of Brine samples. All methods listed in this document have been optimised for Li recovery and include Li specific reference materials where available. Please contact us to discuss your specific needs and to obtain pricing.

For the analysis of Li rich brine samples with no solid component, direct analysis by ICP-OES provides Li determination from 10-3000ppm, along with a suite of commonly associated trace elements. Samples should be filtered in the field and acidified where possible. Acidification in the lab is available for an additional charge, but increases turn-around time by approximately two weeks (samples must stand after acidificaton to resolubilise elements that may have adhered to the container walls).

ICP-400-Li	10ppm - 3000ppm Li	+30 Elements

For brines with lower levels of Li, a combined ICP-OES/ICP-MS package provides Li determination from 0.5-10ppm in addition to a larger suite of trace elements at lower detection limits.

IMS-400-Li	0.5ppm - 10ppm Li	+50 Elements

Li brines are typically processed by reaction with Na carbonate to produce Li carbonate as an intermediate product suitable for refining. The efficiency of the process as well as the total recovery can be impacted by a variety of physical parameters including pH, Conductivity, Total Dissolved Solids (TDS), and Total Alkalinity. These parameters have been grouped into package BRP-400.

BRP-400	pH, Conductivity, TDS and Alkalinity

(Note that a separate sample split is recommended for physical parameters. The sample should be unacidified and the container should be full with no head space to ensure meaningful pH results)

PEGMATITES

Pegmatites are the second largest source of Li (source USGS) comprising 26% of global supply in 2016. Most of the Li bearing phases are complex alumino-silicates such as Petalite, Spodumene, and Lepidolite along with less abundant phases such as the flourophosphate Amblygonite. Average grades tend to be lower than in brine deposits, and the Li bearing phases are highly resistant to acid digestion, making processing and recovery more difficult and expensive.

The same acid resistance that makes pegmatite ores difficult to process, also makes analysis challenging and the high cost of production makes the consequences of low bias more significant. To ensure a total digestion and an assay with 100% recovery, MSALABS recommends a Na peroxide fusion followed by ICP-OES determination of Li from 0.005-30% as well as a limited suite of trace elements.

A larger suite of trace elements at lower detection limits is available using a second reading of the sample on an ICP-MS.

PER-700-Li	0.005% - 30% Li	+17 Elements
IMS-700-Li	5ppm - 30% Li	+50 Elements

Li RICH CLAYS AND SEDIMENTS

Hectorite is the most common Li bearing clay mineral and may contain up to 6000ppm Li in its structure. In some environments, hectorite is formed by hydrothermal alteration of montmorillonite, and in others by direct precipitation from saline waters. In recent years, clays have played an increasingly important role in Li production and represented 7% of global supply in 2016 (source USGS). Many other clays contain Li in small amounts as inclusions, substitutions or adhered to surfaces and may be important in exploration.

Where samples contain clay minerals including Hectorite, or sediments acting as secondary traps for Li as a mobile pathfinder element, MSALABS recommends an Aqua Regia digestion followed by ICP-OES/ICP-MS analysis. This package is also suitable for Li brine samples that also contain evaporitic solids whose Li content needs to be accounted for.

(To further discuss how phase mixtures can affect detection limits and reportable elements, please contact our client service representatives.)

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- PhotonAssay™ Analysis (Gold, Silver and Copper*)
- Sample preparation, storage and disposal
- Precious metals by Fire Assay
- Multi-element packages - Basic, Trace, Ultra-trace
- Fusion, ICP-OES and ICP-MS
- XRF
- Specialty Assay
- Biogeochemistry and Hydrogeochemistry
- Metallurgical Samples Analysis and Services
- Mineralogical Services

** Copper assay only available in select locations and is not currently available in Canada*

STRINGENT QUALITY STANDARDS

Our company maintains the highest quality standards and follows the guidelines of ISO17025 accreditation and ISO9001, ISO14001 and ISO45001 certification. Certificates are available for download from our website.

Additionally, we participate in CDN Labs, Geostats, PTP-MAL, and Rockslabs Proficiency Testing Schemes (PTS), among others.

EXPERTISE IN SITE-BASED LABORATORY MANAGEMENT

We have extensive laboratory design, construction and management experience in a range of countries.

We implement a complete set of systems, training, software and procedures enabling ISO certification and complete regular audits.

Our laboratories are managed by experienced, highly qualified staff, who undertake regular training.

BROAD RANGE OF COMMODITIES

We operate across a broad range of commodities.

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- Silver
- Platinum Group Metals
- Copper
- Rare Earth Elements
- Cobalt
- Lithium
- Lead
- Zinc

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MSALABS

EVERY SAMPLE **SAFELY** MEASURED
EVERY RESULT **RELIABLY** DELIVERED

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