Lithium

An element of growing interest due to modern technology applications

Lithium is the lightest metal on earth, with an atomic number of 3 and atomic mass of 6.94. It has a high heat capacity and electrochemical potential which makes it ideal for technology involving heat transfer such as welding and metallurgical applications.

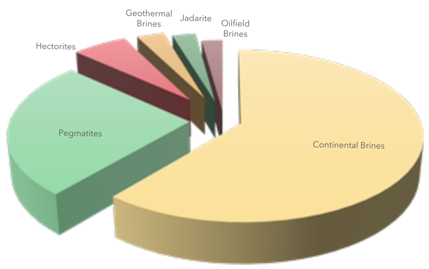
Its chemical properties, light weight and high electrochemical potential also make it highly desirable for batteries, allowing lithium batteries to hold three times the energy of nickel hydride at a third of the weight. Lithium batteries also work at very low temperatures and have a longer battery life.

Lithium is concentrated by magmatic fractional crystallisation and partial melting, resulting in higher concentrations in some pegmatites and muscovite-bearing granites. During weathering, highly soluble lithium is dissolved and transported with water. In places where water is trapped inland under arid conditions, the lithium is concentrated in residual brines. These concentration mechanisms have formed the two types of deposits, pegmatites and continental lithium brines in closed basins, which are the source of most mined lithium. Other sources of viable lithium resources include geothermal brines, jadarite, oilfield brines and clay minerals such as hectorite (Evans, 2013). Lithium is also often produced as a by-product of potash operations. Smith et al (1987) describe a lateritic soil anomaly up to 20km from Greenbushes, which is a 3km long and several hundred metres wide pegmatite. The 12 by 20 km distal anomaly contained the elements As, Be, Sb and Sn, with a more proximal 1 by 5 km anomaly containing an assemblage of Nb, Ta and B. Exploration for lithium can also be aided by pathfinder geochemistry of K, Mg, B, F, Na, Ca, Li/K and Li/Mg ratios. Where lithium is found in trace concentrations, it substitutes for other metals rather than forming distinct lithium minerals. The most common substitution is for Mg^{2+}, the ion closest in size to lithium. Thus, by comparing the ratio of Li to Mg, increased Li substitution can be detected. All elements of interest are reported by ME-MS89L™ except F which cannot be determined as hydrofluoric acid (HF) is part of the analytical process.

Brine water samples may also be analysed for general chemistry including pH, conductivity, alkalinity, total dissolved solids, and Cl or Br. Vegetation samples show anomalous lithium in response to elevated groundwater, and indicator species may provide a useful exploration medium (Cannon, 1975).
Enriched brine occurrences require three factors for economic accumulation: an enriched Li host source rock, a transport mechanism, and concentration, trapping or sorption mechanism. Exploration considerations should include Li-enriched sources such as differentiated rhyolitic or granitic terrane, a groundwater or gaseous mechanism for Li transport and accumulation, and concentration or trapping via evaporation or clay sorption.

Lithium Background Concentrations:

- Natural waters: 1-3 ppb
- Sea water: 170 ppb
- Shales: 66 ppm
- Deep-sea clays: 57 ppm
- Soil samples: 20-200 ppm depending upon underlying host rock
- Ultramafic rocks: 0.5 ppm
- Granitic rocks: 40-100 ppm
- Micaceous schists: 50-200 ppm
- Pegmatites: 100-2,000 ppm
- Continental brines: 50 ppb-2,000 ppm
- Great Salt Lake: 60 ppm Li
- Salton Sea: 200 ppm Li
- Chabyer salt-lake: 0.12% Li
- Salar de Atacama: 200 ppm-0.18% Li



Geologic Source of Global Lithium Resource. Estimates from Keith Evans (2009).

ALS offers a range of methods suitable for all matrix types and at all stages of a project, from exploration to resource definition and grade control. For assistance in selecting the appropriate analytical method for your needs, please contact your local ALS Client Services Department. When submitting your samples, please indicate that the commodity target is lithium, especially when selecting multi-element packages. This will allow ALS to include lithium specific Certified Reference Materials for the highest quality results and transparency of laboratory performance.

References

Cannon, H.L., Harms, T.F., and Hamilton, J.C. 1975. *Lithium in Unconsolidated sediments and plants of the Basin and Range Province, Southern California and Nevada.* Geological Survey Professional Paper 918. Department of the Interior.

Evans, R.K., 2009. Lithium. *in Lithium Supply and Markets.* Conference: Industrial Minerals magazine. Santiago, Chile.

Evans, R.K., *2013. Lithium, chap. 10 in Gunn, G, ed., Critical Metals Handbook.* Wiley, pp.

230-260.

Smith, R.E., Perdrix, J.L., and Davis, J.M., 1987, *Dispersion into pisolitic laterite from the Greenbushes mineralized Sn-Ta pegmatite system,* Western Australia: Journal of Geochemical Exploration, v. 28, nos. 1-3, p. 251-265.

Code	Analytes & ranges	Description
ME-MS89L™	Li 2ppm–2.5%, Mg 0.01–30%; various other elements; MP* – 10%	Lowest detection limits using Na_2O_2 fusion and ALS's super trace ICP-MS methodology. A package suitable for exploration in pegmatites prospective for Li and accessory commodities. Boron may be added at an additional cost.
ME-ICP89	Li 0.001–10%; various other elements; MP* – 7.5%	Economical exploration method for Li-bearing pegmatites using a Na_2O_2 fusion and ICP-AES finish. Includes all major elements and some key trace elements in addition to lithium.
ME-ICP82b	Li 0.001–10%, B 0.02–10%; MP* – 5%	Low level ore grade Li and B by Na_2O_2 fusion and ICP-AES analysis. Ideal for jadarite and Li/B-bearing pegmatites.
ME-ICP41	Li 10 ppm–1%; various other elements; MP* – 10%	Intermediate level Li analysis suitable for exploration of Li-bearing sediments, carbonates and evaporites. Aqua regia and ICP-AES finish, including Li-specific CRMs.
ME-ICP61	Li 10 ppm–1%; various other elements; MP* – 10%	Intermediate level Li analysis suitable for exploration of Li-bearing sediments. Four-acid digestion and ICP-AES finish, including Li-specific CRMs.
Li-OG63	Li 0.005–10%; MP* – 5%	Ore grade Li by specialised four-acid digestion and ICP-AES finish, with Li-specific CRMs. Best suited to Li-bearing silicate sediments.
ME-MS14™	Li 10-10000 ug/L; various other elements; MP* – 10%	Trace level analysis of Li in brine samples, run as-is on the ICP-MS. If lab filtration or acidification is required, please indicate this on the submittal form.
ME-ICP15	Li 0.5-20000 mg/L; various other elements; MP* – 10%	Intermediate to high level analysis of Li and other elements in brine samples, run as-is on the ICP-MS. If acidification is required, please indicate this on the submittal form.

* MP – method precision.

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