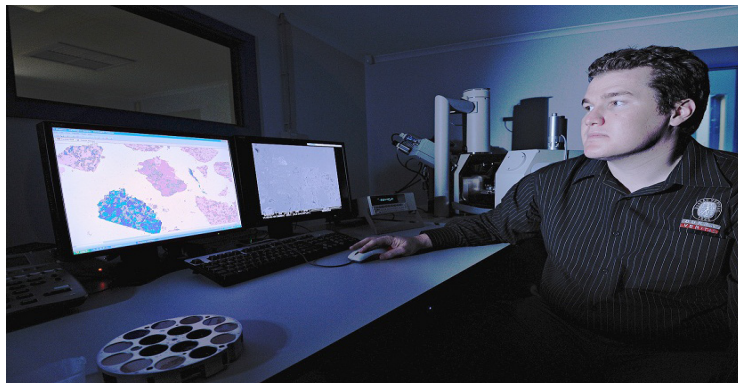
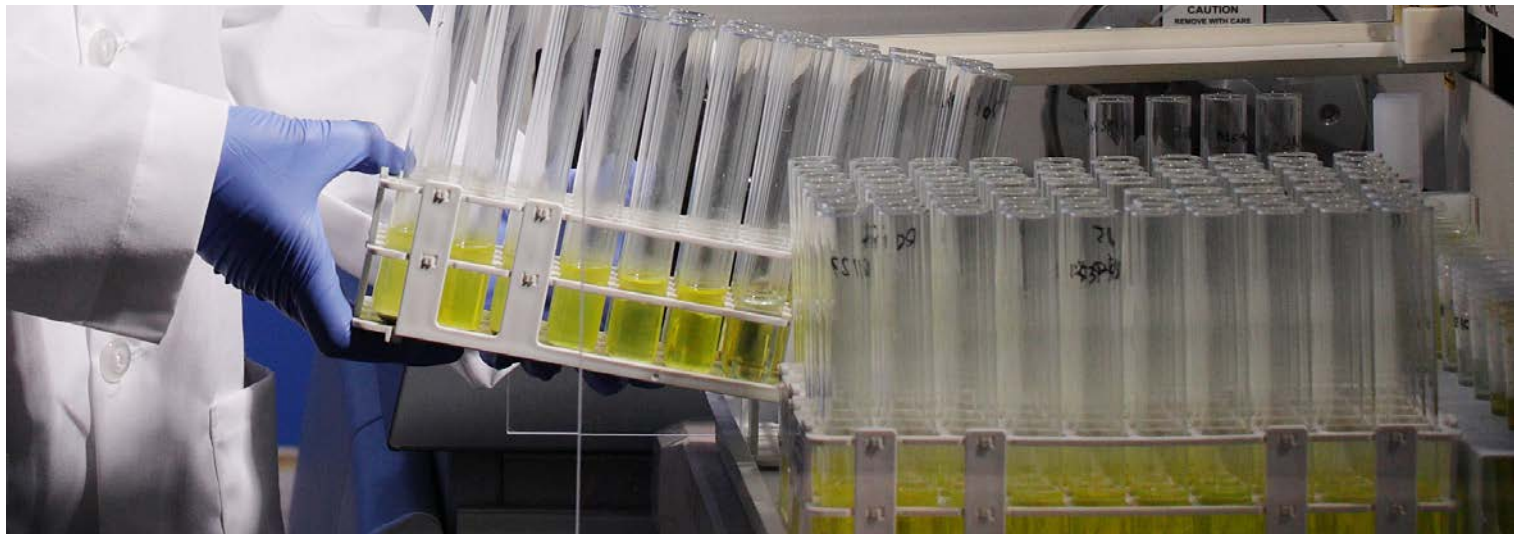


# BUREAU VERITAS

## Metals & Minerals



# Lithium Testing

## Tests & Techniques



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# Where is your Lithium?

Global lithium supplies are obtained from two primary sources.

## Brines and Evaporites

Lithium is liberated by weathering or may be derived from hydrothermal fluids from a variety of rock sources. Ground water brine solutions containing dissolved lithium accumulate in closed basins. Economic brines typically contain 200 – 4000 mg/l of lithium, and are pumped to the surface and concentrated by evaporation.

## Hard Rock

The most common and economic lithium-bearing minerals are shown in the following table.

Mineral	Formula	Member	Li (%)
Spodumene	$\text{LiAlSi}_2\text{O}_6$	Pyroxene	3.7
Lepidolite	$\text{K}_2(\text{Li})_{3-4}\text{Al}_{8-5}\text{Si}_{6-8}\text{O}_{20}(\text{F},\text{OH})_4$	Mica	1.4-3.6
Mica Group	$\text{X}_2\text{Y}_{4-6}\text{Z}_8\text{O}_{20}(\text{OH},\text{F})_4$ X = K, Na, Ca, Ba, Rb, Cs Y = Al, Mg, Fe, Mn, Cr, Ti, Li Z = Al, Si		
Petalite	$\text{LiAlSi}_4\text{O}_{10}$	Feldspathoid	1.6-2.3
Amblygonite	$(\text{Li},\text{Na})\text{Al}(\text{PO}_4)(\text{F},\text{OH})$	Amblygonite	3.4-4.7
Triphylite-lithiophilite	$\text{Li}(\text{Fe},\text{Mn})\text{PO}_4$	Olivine	4.4

## Assay Techniques

**Brines and Evaporites may be analysed by:**

- ICP-ES for Al, Ba, Ca, Fe, K, Li, Mg, Na, and  $\text{SO}_4$  and other minor elements
- ICP-MS for Br, Cs, I, and Rb and other trace elements.
- Volumetric methods for Cl,  $\text{HCO}_3$  and  $\text{NH}_4$
- Colorimetric methods for Cl,  $\text{NO}_3$ , and  $\text{PO}_4$
- Ion Selective Electrode for F.

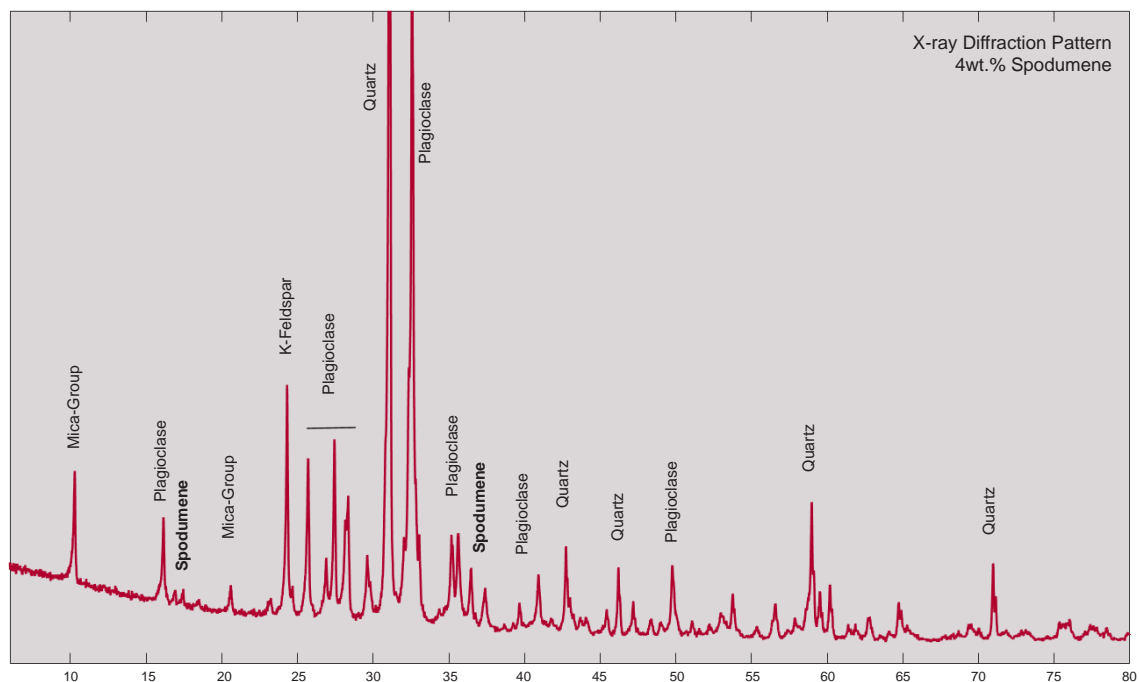
**Hard Rock:**

Geochemical analysis of lithium bearing pegmatite ores can be obtained using a peroxide fusion. The sample is fused with sodium peroxide in a zirconium crucible. The melt is dissolved in dilute HCl and the solution analysed by ICP-ES and ICP-MS. Key pathfinder elements are highlighted.

ICP-ES (ppm)								
Li (50)	Al (100)	Ca (1000)	Fe (100)	K (1000)	Mg (100)	Mn (10)	P (100)	Ti (100)
ICP-MS (ppm)								
Li (1)	Cs (1)	Rb (0.5)	Sn (10)	Ta (0.5)	W (5)			

# Mineralogy

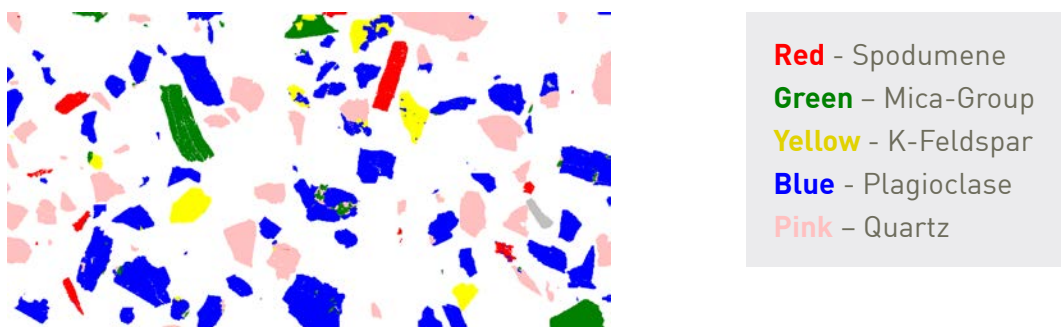
The XRD pattern of a hard rock exploration sample containing 0.24% Li (by chemical assay) is shown. XRD clearly identified the primary Li bearing mineral is Spodumene at a concentration of 4wt.%, however it cannot detect solid solution elements, such as Li in the mica. The Li content of the sample calculated from QXRD was 0.16%.



In most cases, automated mineralogy using QEMSCAN/MLA will be able to determine element deportment, however, it is not possible to detect Li by QEMSCAN/MLA due to the limitations of the XRF detector.

The deportment of Li was determined in the sample by Laser Ablation ICP-MS spot analysis.

The Laser Ablation results indicate that up to 30% of the Li content is deported to the Micas. This was undetectable by QEMSCAN, XRD or chemical assay, and is critical information for determining metallurgical processes.

[illegible]

# Metallurgical Testing and Flow Sheet Development

## Brines and Evaporites

- Characterisation of brines and Evaporites (chemical assay, QXRD, QEMSCAN)
- Crystallisation trials – Controlled crystallisation of salts
- Flotation testwork – upgrade of key Li minerals by flotation or reverse flotation
- Beneficiation methods – pilot plant test work

## Hard Rock

- Mineralogical characterisation – XRD, QEMSCAN, Laser Ablation ICP-MS
- Comminution testwork
- Head assay and size fraction assays – potential to reject sub-economic fractions based on size
- Gravity beneficiation – separation of impurities based on mineral density
- Flotation beneficiation – upgrade of key Li minerals by flotation or reverse flotation

**Bureau Veritas Minerals holds the key to finding your Lithium.  
Contact one of our experts today.**



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