technos instruments
Solutions through Technology

Raman Spectroscopy for Detection of Critical Minerals and Rare Earth Elements (REEs) : Lithium

INTRODUCTION

Critical minerals such as **lithium, cobalt, nickel, graphite**, and **rare earth elements (REEs)** play a central role in emerging technologies including electric vehicles, renewable energy storage systems, and advanced electronics. With increasing global demand, there is a strong requirement for **rapid, precise, and non-destructive** techniques for mineral identification.

Conventional analytical methods—such as X-ray diffraction (XRD) and inductively coupled plasma mass spectrometry (ICP-MS)—provide high accuracy but are often **time-consuming, destructive**, and unsuitable for **on-site analysis** during exploration. In contrast, **Raman spectroscopy** offers a fast, non-destructive approach capable of identifying minerals through their distinct **molecular vibrational signatures**. The high chemical specificity of Raman scattering enables reliable differentiation of structurally similar lithium-bearing minerals, including **Amblygonite, Lepidolite, and Petalite.**

In this study, TechnoS Instruments evaluated these lithium minerals using the **IndiRAM™ CTR Raman spectrometer**, demonstrating its capability for accurate mineral discrimination and supporting the development of a **portable Raman platform** for field-based applications.

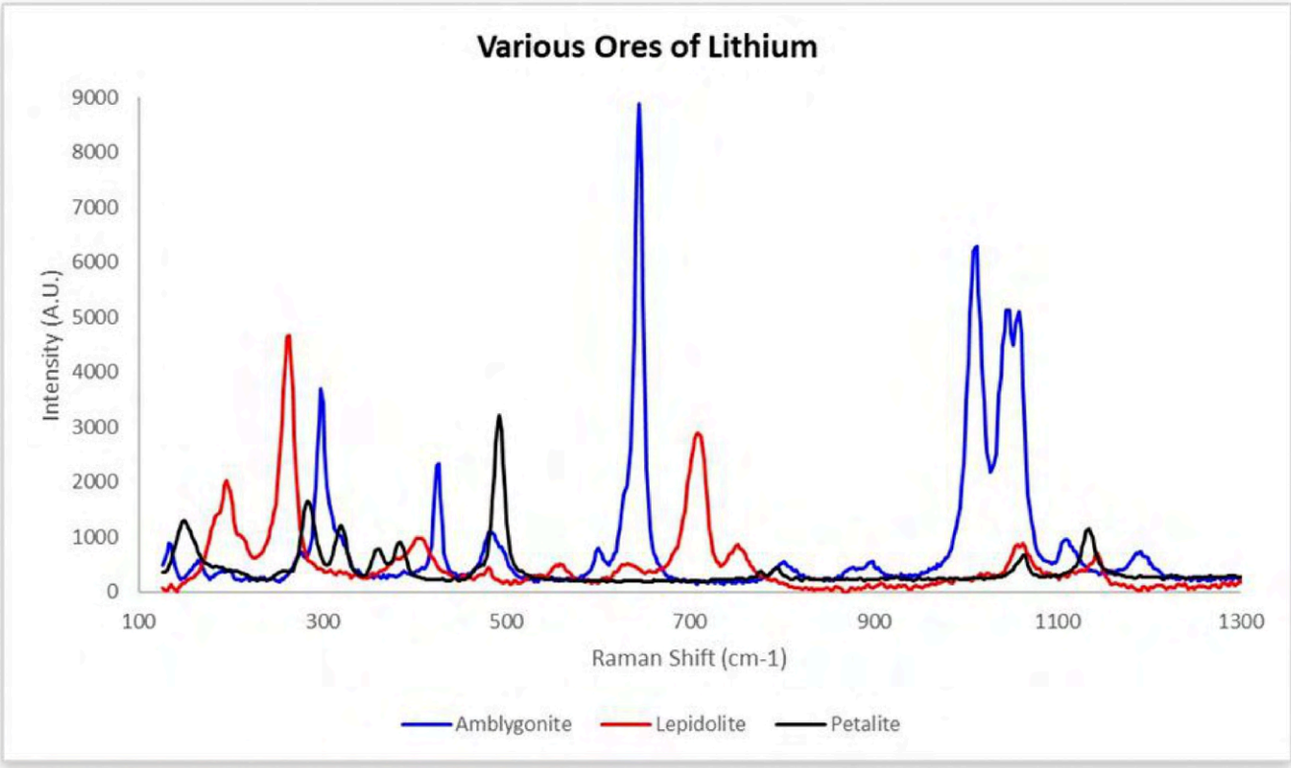
MATERIALS AND METHODS

Raman spectra were acquired using the **TechnoS IndiRAM™ CTR Raman spectrometer**, engineered to provide high spectral resolution, excellent signal-to-noise performance, and optical stability—characteristics essential for geological and mineralogical analysis.

Three primary lithium-bearing mineral species were examined:

- **Amblygonite** – $(Li,Na)AlPO_4(F,OH)$: Lithium–aluminium phosphate
- **Lepidolite** – $K(Li,Al)_3(Al,Si)_4O_{10}(F,OH)_2$: Lithium mica
- **Petalite** – $LiAlSi_4O_{10}$: Lithium–aluminium silicate

Each mineral possesses distinct structural motifs that result in characteristic Raman vibrational features.



RESULTS AND DISCUSSION

Amblygonite

Exhibits strong phosphate vibrational bands near **~700 cm^{-1}** and **~1100 cm^{-1}**, consistent with PO_4^{3-} symmetric and antisymmetric stretching modes.

Lepidolite

Shows distinct layered silicate lattice vibrations, notably within the **250–350 cm^{-1}** region, along with an additional feature near **~750 cm^{-1}**, characteristic of lithium-rich mica structures.

Petalite

Displays diagnostic Li–Al silicate vibrational bands between **350–500 cm^{-1}**, corresponding to bending and stretching modes of the aluminosilicate framework.
These spectral differences provide clear mineralogical discrimination, enabling rapid identification of lithium ore types.

CONCLUSION

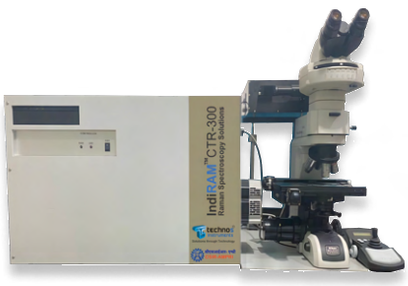
The distinct Raman signatures of **Amblygonite, Lepidolite, and Petalite** enable precise and rapid identification of lithium-bearing minerals, reinforcing Raman spectroscopy as an effective, non-destructive tool for **geological exploration** and **mineral processing workflows.**

Leveraging this capability, TechnoS Instruments is advancing the development of a **portable Raman spectrometer** designed for **real-time, on-site mineral identification**. This field-ready system will support rapid geological mapping, lithium screening, and REE detection without dependence on laboratory facilities, thereby improving efficiency and decision-making in mineral exploration.

REFERENCE

1. Rinaudo, C., Gastaldi, D., & Croce, G. Raman characterization of lithium aluminosilicates. Journal of Raman Spectroscopy, 36, 810–816 (2005).
2. Dias, A., & Prudêncio, M.I. Raman analysis of lithium minerals. Spectrochimica Acta Part A, 199, 236–244 (2018).
3. McMillan, P.F. Vibrational spectroscopy of silicates. Physics and Chemistry of Minerals, 16, 245–254 (1988).

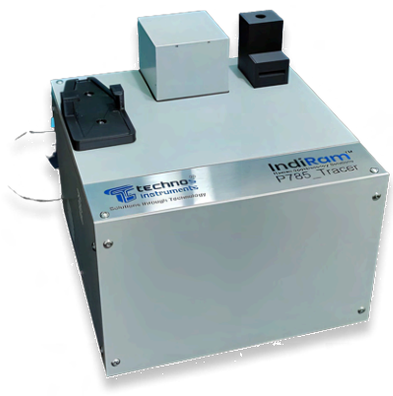
OUR PRODUCTS



IndiRAM™ CTR Series

IndiRAM™ CTR for Quantum Characterizer

IndiRAM™ CTR Series Chiral Raman Spectrometer



IndiRAM™ Edu

IndiRAM™ CTR P-Series

IndiRAM™ Portable System

Diamond Detection System

IndiRAM™ Handy Series

IndiRAM™ CTR-Mini Series

technos instruments
Solutions through Technology

G1-43, RIICO Industrial Area, Sitapura, Jaipur, Rajasthan 302022

www.technosphotonics.com

info@technos.in

+91 8003220052