



























# XRD in Critical Minerals Analysis

## Quick Reference Guide: Mineral Measurement Matrix

 Element	XRD Use Case
<b>Lithium (Li)</b>	<ul style="list-style-type: none"><li> Quantify spodumene, petalite, lepidolite vs gangue in raw ore</li><li> Distinguish <math>\alpha</math>- vs <math>\beta</math>-Spodumene during roasting</li><li> Monitor Li-carbonates and other phases during leaching</li><li> Detect gangue and secondary phases post-roasting</li></ul>
<b>Rare Earths (REE)</b>	<ul style="list-style-type: none"><li> Identify REE phases: monazite, bastnaesite, xenotime</li><li> Assess crystallinity of REE-bearing minerals</li><li> Detect secondary phosphates/carbonates from leaching</li><li> Ensure phase purity in final REE product</li></ul>
<b>Nickel (Ni)</b>	<ul style="list-style-type: none"><li> Identify Ni minerals: pentlandite, garnierite, violarite</li><li> Profile laterite zones: limonite vs saprolite</li><li> Track phase changes during acid leaching or HPAL</li><li> Monitor Ni phase transitions during roasting</li></ul>
<b>Cobalt (Co)</b>	<ul style="list-style-type: none"><li> Confirm cobaltite vs linnaeite in sulfide ores</li><li> Monitor Co mineral phase changes during processing</li><li> Quantify spinel vs layered Co-bearing phases</li><li> Track phase transitions during roasting/sintering</li></ul>
<b>Copper (Cu)</b>	<ul style="list-style-type: none"><li> Identify Cu minerals: chalcopyrite, bornite, malachite</li><li> Differentiate sulfide vs oxide ore types</li><li> Track phase changes during acid or bioleaching</li><li> Monitor chalcopyrite/bornite ratio in flotation</li></ul>
<b>Graphite (C)</b>	<ul style="list-style-type: none"><li> Identify graphite phases and structural forms</li><li> Assess crystallinity and flake quality</li><li> Measure <math>d_{002}</math> spacing to evaluate graphitization</li><li> Quantify mineral matter and gangue composition</li></ul>

 Field and Lab Tips	XRF	XRD
Rapid elemental composition is needed	✓	
On-site screening is essential (e.g. handheld units)	✓	
Mineralogical phase identification is critical		✓
Structural/crystallinity data affects processing outcomes		✓
You need to confirm transformations or complex mineralogy		✓