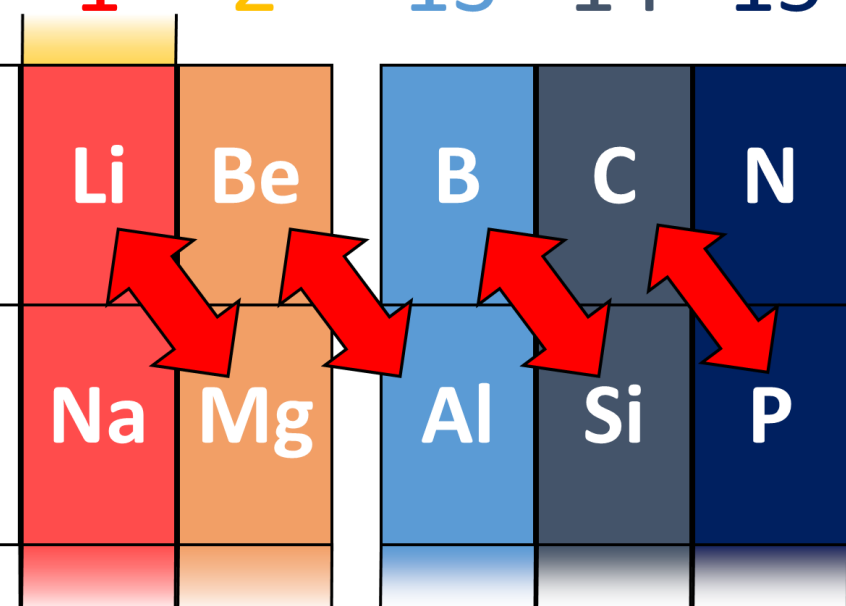

Anomalous Behaviour of Lithium & Beryllium (Diagonal Relationship)

Visual Concept: S-Block Periodic Table Position

main group

	1	2	13	14	15
period 2	Li	Be	B	C	N
period 3	Na	Mg	Al	Si	P



The diagram illustrates the S-block elements (Li, Be, Na, Mg) and their positions relative to the main group elements (B, C, N, Al, Si, P) in periods 2 and 3. Red arrows indicate the diagonal relationship between Li and Be, Na and Mg, and the subsequent elements in the main group.

Visual Concept: S-Block Periodic Table Position



Lithium



Magnesium



Aluminum

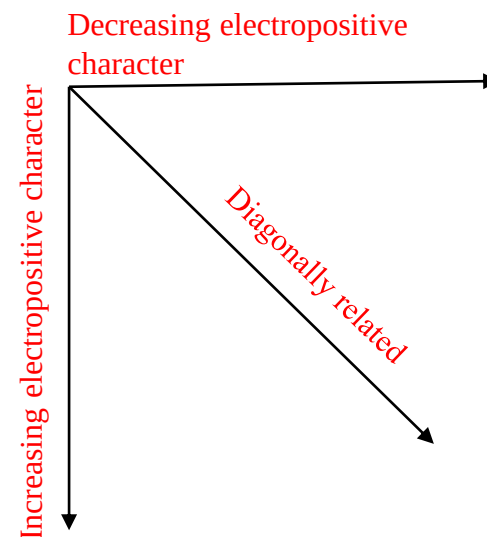


Beryllium

Fundamental Causes of Anomalies

Cause of Diagonal Relationship: -

1. Similar electropositive character – As we move from left to right in a period electropositive character decreases and while going down a group, electropositive character increases. Therefore, on moving diagonally, the two opposing tendencies almost cancel out and the electropositive character is almost same as we move diagonally.
2. Polarizing power – On moving from left to right in a period, the ionic charge increases while the ionic size decreases, thus causing an increase in polarizing power. On the other hand on moving down a group, the ionic charge remains the same while the ionic size increases and , therefore the polarizing power decreases. As a result of these two opposite changes on moving diagonally these two effects partly cancel each other and therefore, the two elements have almost similar polarizing power.



Diagonal Relationship Mechanism

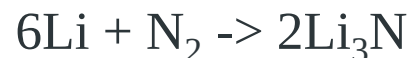
- **Balancing Periodic Trends:** Moving diagonally down-right compensates for the regular group sizes and charge shifts.
- **Similar Ionic Potential:** Charge/size ratios of Li matches Mg, and Be aligns directly with Al.
- **Resulting Homogeneity:** Creates highly accurate physical and chemical behavioral mapping between these pairs.

Important characteristics of distinction b/w Li & Group I elements

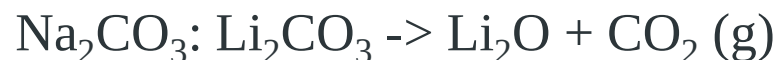
- Extreme Physical Hardness: Unlike Sodium (Na) and Potassium (K) which can be sliced with a butter knife, Li is highly tough.
- Abnormally Elevated Melting & Boiling Points: Li melting threshold sits at a high 454 K compared to peers.
- Remarkable Air Stability: Slow oxidation curve, whereas Na and K auto-ignite instantly in moist ambient atmospheric air.
- It forms monoxides with oxygen while other members except Na form superoxides.
- The salts of less ionic character as compare to Li due to higher polarizing power.
- It readily react with nitrogen to form nitrides while others do not easily react.
- Only Li reacts with carbon and silicon to form carbide and silicide.
- LiOH is much less basic than other hydroxides.

Lithium vs Group 1: Advanced Chemical Equations

- Direct Ambient Nitrogen Fixation: Only Group 1 metal to form stable Nitrides directly:



- Thermal Carbonate Instability: Decomposes easily on heating unlike stable



- Predominant Covalent Character: Lithium Chloride (LiCl) is highly deliquescent and easily soluble in organic solvents like ethanol.

Li-Mg Similarities

- The atomic radius of Li is 1.52 °A while that of Mg is 1.60 °A
- Both are quite hard in nature.
- Both LiOH and Mg(OH)₂ are weak base.
- Both form monoxides Li₂O and MgO
- Direct Nitride Generation: Both elements combine actively with nitrogen to form crystalline nitrides (Li₃N and Mg₃N₂).
- Thermal Decomposition Path: Both carbonates dissolve cleanly into pure metal oxides liberating CO₂:
$$\text{MgCO}_3 \longrightarrow \text{MgO} + \text{CO}_2$$
$$\text{Li}_2\text{CO}_3 \longrightarrow \text{Li}_2\text{O} + \text{CO}_2$$
- Organic Solvent Solubility: Chlorides (LiCl & MgCl₂) exhibit strong covalent traits, dissolving efficiently in alcohol.
- Lithium hydroxide, fluoride, phosphate, oxalate and carbonate are much less soluble than the corresponding Na and K salts. But the solubilities are comparable to those of Mg salts.

Beryllium vs Group 2: Structural Differences

- Covalent Compound Chemistry: Due to exceptional polarization force, Be compounds are predominantly covalent.
- Absolute Water/Steam Inertness: Completely unreactive with water or vapor even at red-hot thermal status, while Mg reacts easily.
- Highest Melting Metric: Beryllium holds an exceptionally high melting point of 1560 K compared to alkaline earth group peers.

Beryllium vs Group 2: Advanced Chemical Reactions

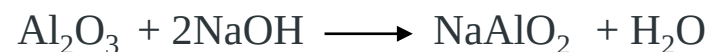
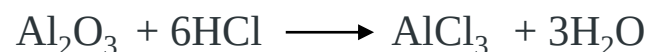
- Amphoteric Character of Oxide/Hydroxide: BeO interacts directly with both mineral acids and strong bases:



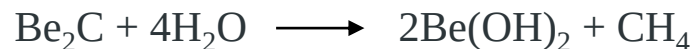
- Coordination Constraints: Limited strictly to a maximum coordination number of 4: $[\text{BeF}_4]^{2-}$ is stable, while Mg reaches 6.

Deep Dive Matrix: Be-Al Similarities

- Both Be and Al form covalent compounds.
- Both BeO and Al₂O₃ are amphoteric in nature.



- Nitric Acid Passivation: Surface protection film formation blocks interactions with concentrated HNO₃.
- BeCl₂ and Al₂Cl₆, both has a bridged polymeric structure.
- Hydrolysis Gaseous Byproducts: Both carbides generate flammable methane gas upon interaction:



- Both the metals are electropositive in nature.
- Halides of both Be and Mg have same solubilities.

Summary & Main Takeaways

- Anomalous behavior is a direct consequence of atomic specifications (Extreme small radii, high charge density).
- Diagonal relationships serve as a prime model for predicting chemical behaviors across neighboring groups.
- Understanding these deviations provides a clean bridge to multi-valence structural d-block chemistry.

Q&A / Thank You
