Elucidation of enrichment factor of Li in geothermal water: study case of geothermal systems in Indonesia

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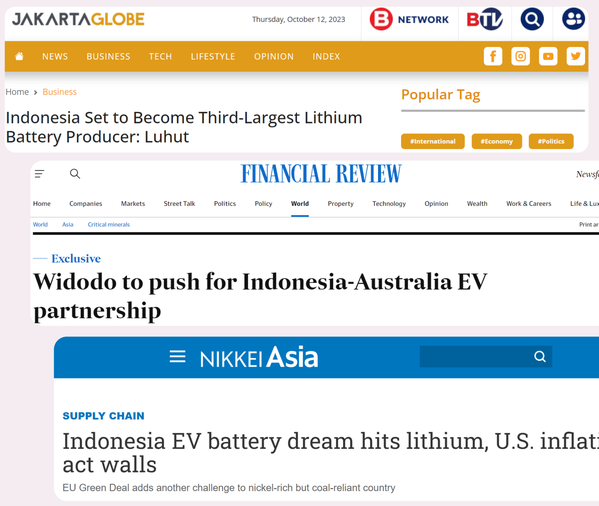
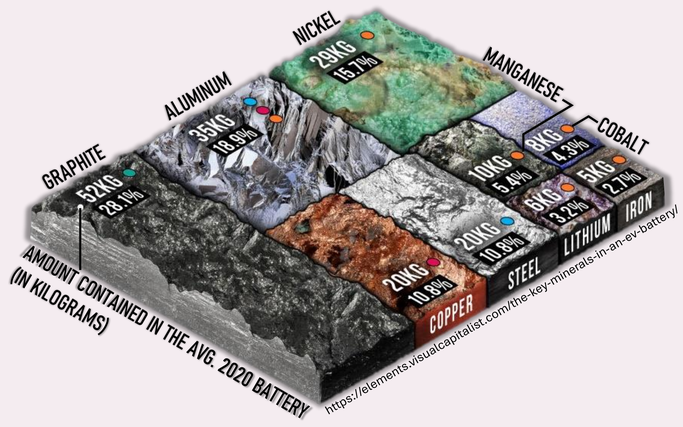
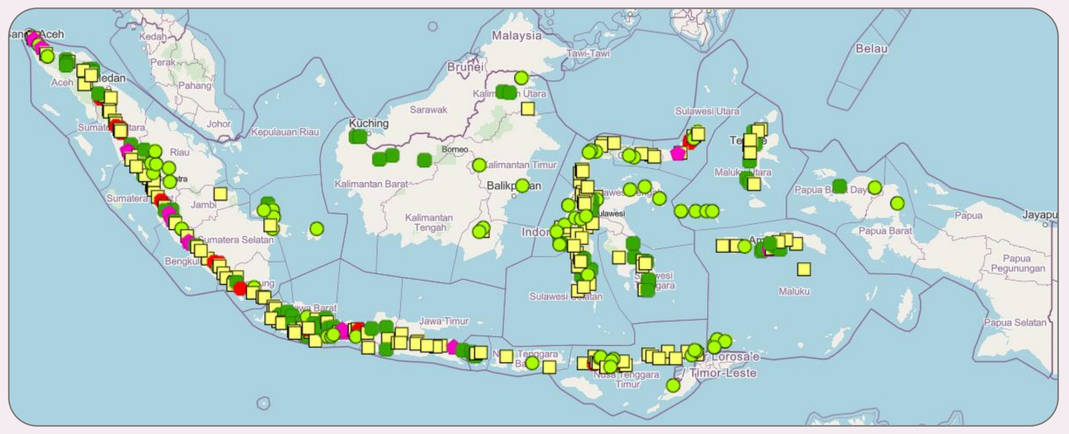
Research Background



Driven by the rapid exploitation of Nickel laterite deposit, Indonesia desires to become **world's EV battery producer**.



To this day, all available EV battery technologies require **Lithium as the key ingredient**.
But >70% of world's Lithium supply is controlled by 2 countries (Australia and Chile) from 2 deposits (continental brine and pegmatite).
Indonesia lacks both types of **Lithium deposit.**



Map of geothermal energy potential in Indonesia (https://geoportal.esdm.go.id/ebtke/)

Indonesia is **blessed with geothermal potential**. White (1957) identified that geothermal water has the highest Li concentration among other surface water. However, the actual **Li potential** from geothermal water in Indonesia has not been thoroughly studied and **factors controlling Li enrichment** in geothermal water has not been fully understood.

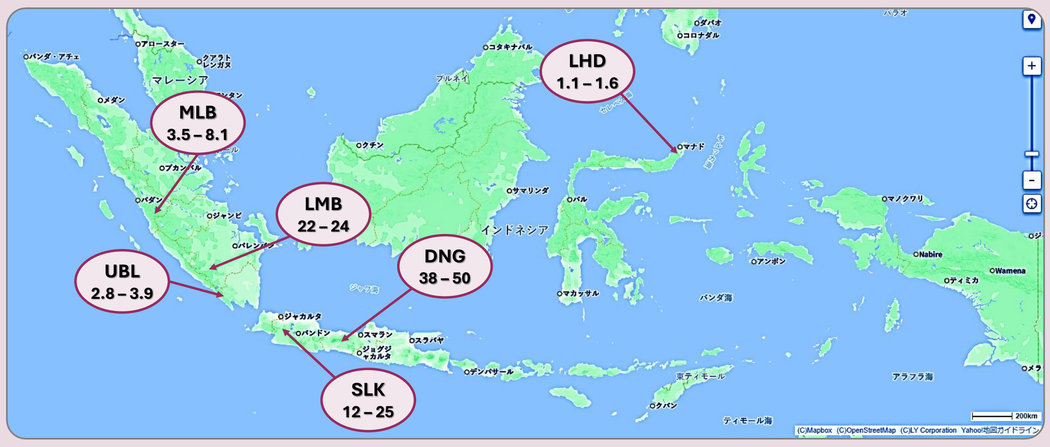
Objective and Strategy

- To **explore** the actual **Lithium potential** in Indonesia's water-dominated geothermal system.
- Furthermore, this study also aims to know and **quantify factors** controlling Lithium **enrichment** in geothermal water for future exploration.

This is to further elevate geothermal as a green **energy resource and mineral resource**.

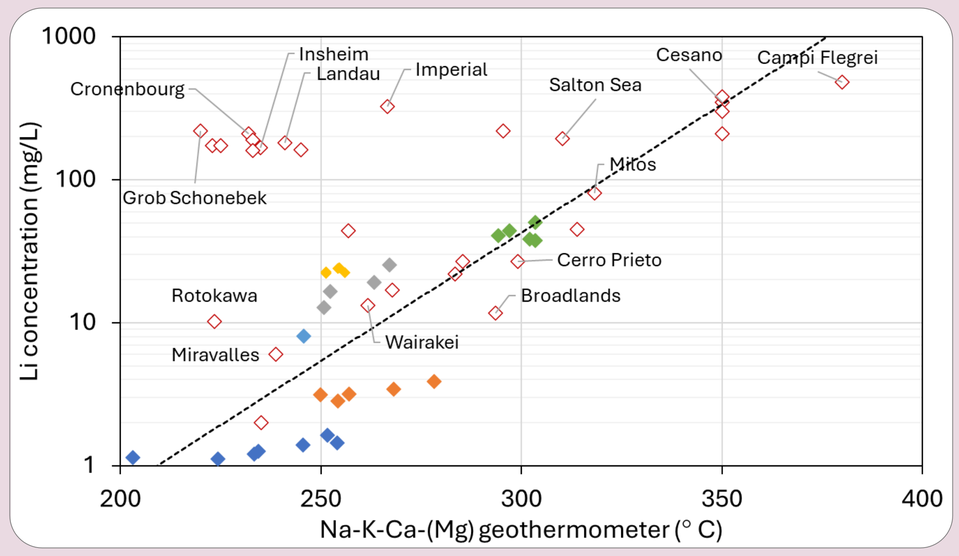
Sample collection → **Analysis** → **Review and Interpretation** → **AI-modelling** → **Enrichment factor**

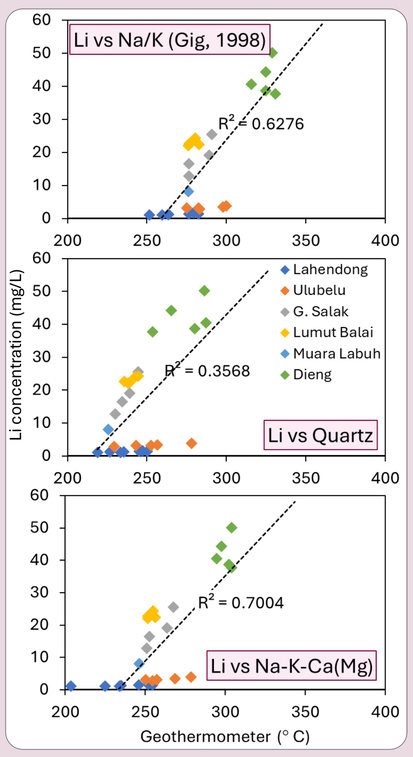
Results and Discussion



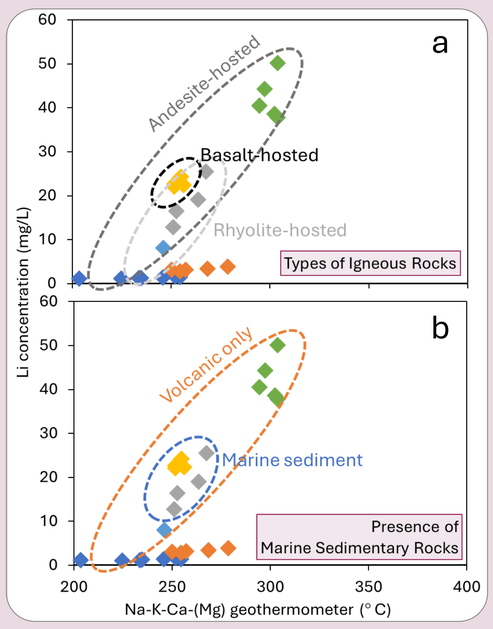
Sampling locations for geothermal water and the range of Li concentration in mg/l. Samples were collected from production pipeline after steam separation and condensation.

Comparison between data from Indonesia and other well-known geothermal systems from Sanjuan *et al.* (2022) and Gallup (1998). Most geothermal systems follow an exponential regression line (black dashed, but some Li-rich geothermal systems deviate very far.





Correlation between Li concentration and the calculated temperature from solute Geothermometry. Na-K-Ca-(Mg) geothermometer (Fournier & Potter, 1979) gives better linear regression value than Na/K (Giggenbach, 1988) and quartz geothermometer (Fournier & Potter, 1982).



Distribution of Li concentration based on the types of igneous rock (a) and the presence of marine sedimentary rock (b) in the reservoir.

Rhyolite-hosted reservoir give 1.1 – 25.5 mg/L of Li, while andesite- and basalt-hosted reservoir give 1.1 – 50.2 and 22.1 – 24.3 mg/L of Li, respectively.

Geothermal systems hosted only by volcanic rock give 1.1 – 50.2 mg/L of Li, while those hosted also by marine sedimentary rocks give 12.8 – 25.5 mg/L of Li

	Contribution [%]	Contribution_ positive [%]	Contribution_ negative [%]
Na-K-Ca-(Mg) geothermometry	23.17	19.92	3.25
Cl/B ratio in geothermal water	22.30	18.80	3.50
Presence of marine sedimentary rock in reservoir	21.04	18.00	3.04
Types (felsicity) of igneous rock	14.50	9.26	5.24
Degree of crystallinity of igneous rock	18.99	3.32	15.68

AI-assisted calculation of **contribution factor** of some parameters to the enrichment of Li in geothermal water. Reservoir temperature gives the highest positive contribution. On the contrary, degree of crystallinity of igneous rock gives negative contribution to the enrichment of Li in geothermal water.

Summary

- Concentration of Li in geothermal water is correlated to the **temperature of reservoir**.
- Fluid with a signature of **seawater mixing** (high Cl/B ratio) tend to have higher Li concentration.
- The presence of **marine sedimentary rock** in the reservoir leads to higher Li enrichment than in the case of its absence at the same temperature.
- The **type of igneous rock** in the geothermal reservoir does not strongly affect Li enrichment in geothermal water, while their degree of crystallinity negatively affect Li enrichment.

Selected references

Gallup, D. L. (1998). *Ore geology reviews*, 12(4), 225-236.
Sanjuan, B., *et al*. (2022). *Geothermics*, 101, 102385.
White, D. E. (1957). *Geological Society of America Bulletin*, 68(12), 1659-1682.

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