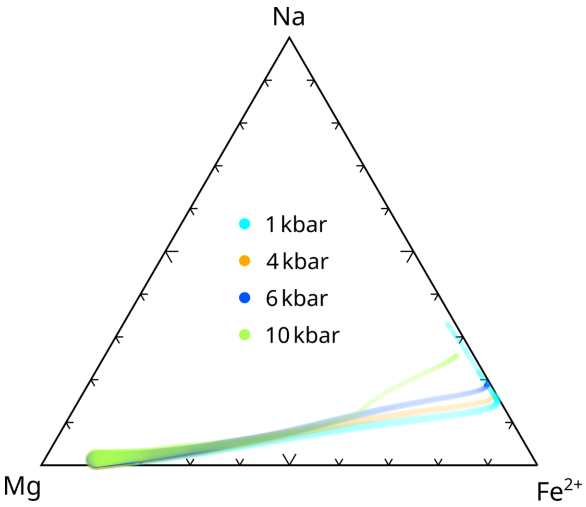
Goldschmidt 2025 Abstract
https://doi.org/10.7185/gold2025.30314

Global controls on clinopyroxene evolution in peralkaline magmas and implications for critical metal enrichment

BRENAINN P SIMPSON[1], CAROLINE R SODERMAN[2], TERESA UBIDE[1], OWEN M WELLER[2], CHARLES BEARD[3], CARL SPANDLER[4] AND JACK WARD[5]

[1]The University of Queensland
[2]University of Cambridge
[3]Utrecht University
[4]University of Adelaide
[5]University of Tasmania



Early observations noted clinopyroxene compositions in peralkaline magmas evolve along two broad trends when plotted on a Mg-Fe^{2+}+Mn-Na ternary diagram. Trend 1 begins at the Mg end member and evolves somewhat directly towards the Na endmember whilst Trend 2 evolves from the Mg end member towards the Fe2+ endmember before evolving towards the Na endmember. Crucially, Trend 2 is preferentially linked with economic enrichment REE and HFSE, which are critical metals for the green energy transition. However, the global occurrence and implications of such evolutionary trends have remained underexplored.

To investigate the origin and implications of this relationship, we use global clinopyroxene data made available via GEOROC to relate variations in clinopyroxene composition to emplacement style (i.e., plutonic versus extrusive), degree of SiO2 saturation, and tectonic setting. From this we propose an empirical relationship between SiO2 saturation and fractionation pathways. To test this hypothesis, we utilise a new THERMOCALC thermodynamic library for alkaline silicate magmas to model the evolution of clinopyroxene in peralkaline magmas at a range of pressures. Preliminary models suggest that the increase in Na driven by increasing pressure from 1 to 10 kbar is not sufficient to switch from Trend 2 to Trend 1. On going work will continue to test a variety of parameters including variable SiO2 activity and oxygen fugacity.