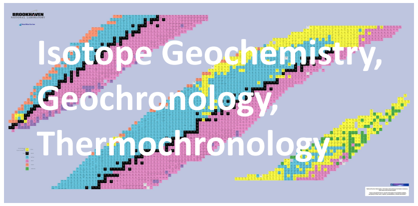

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Controls on the Formation of Porphyry Copper and Gold Deposits

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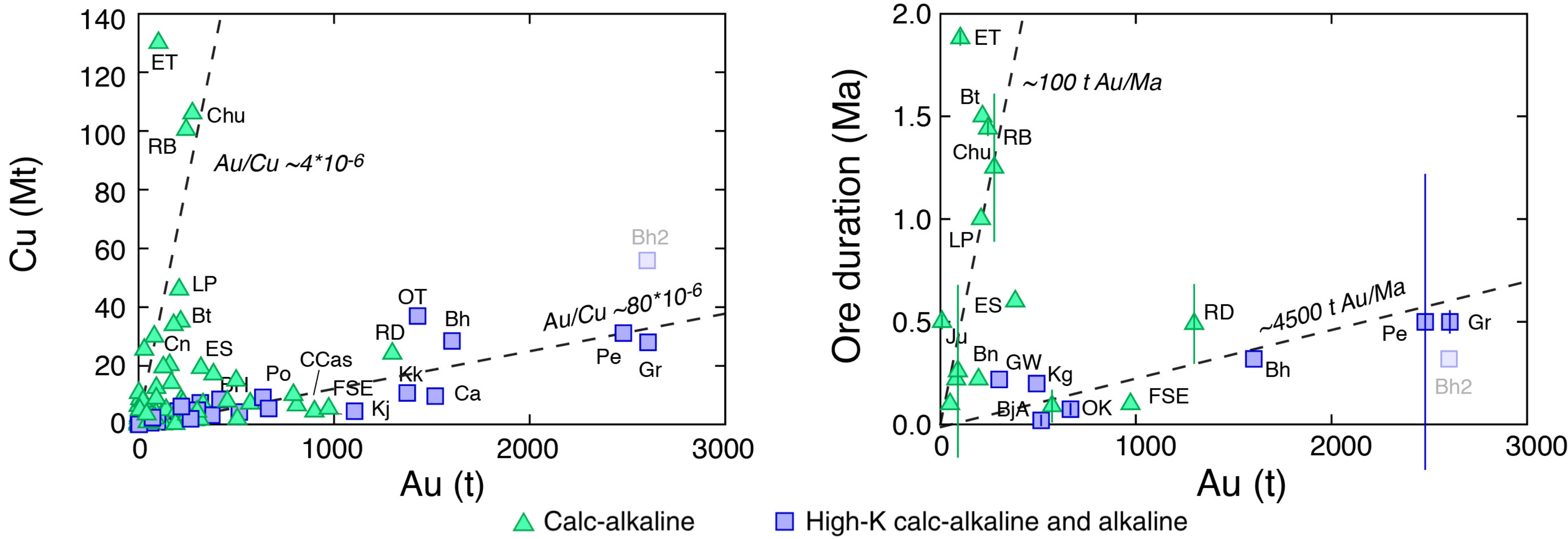
Cu-rich versus Au-rich porphyries

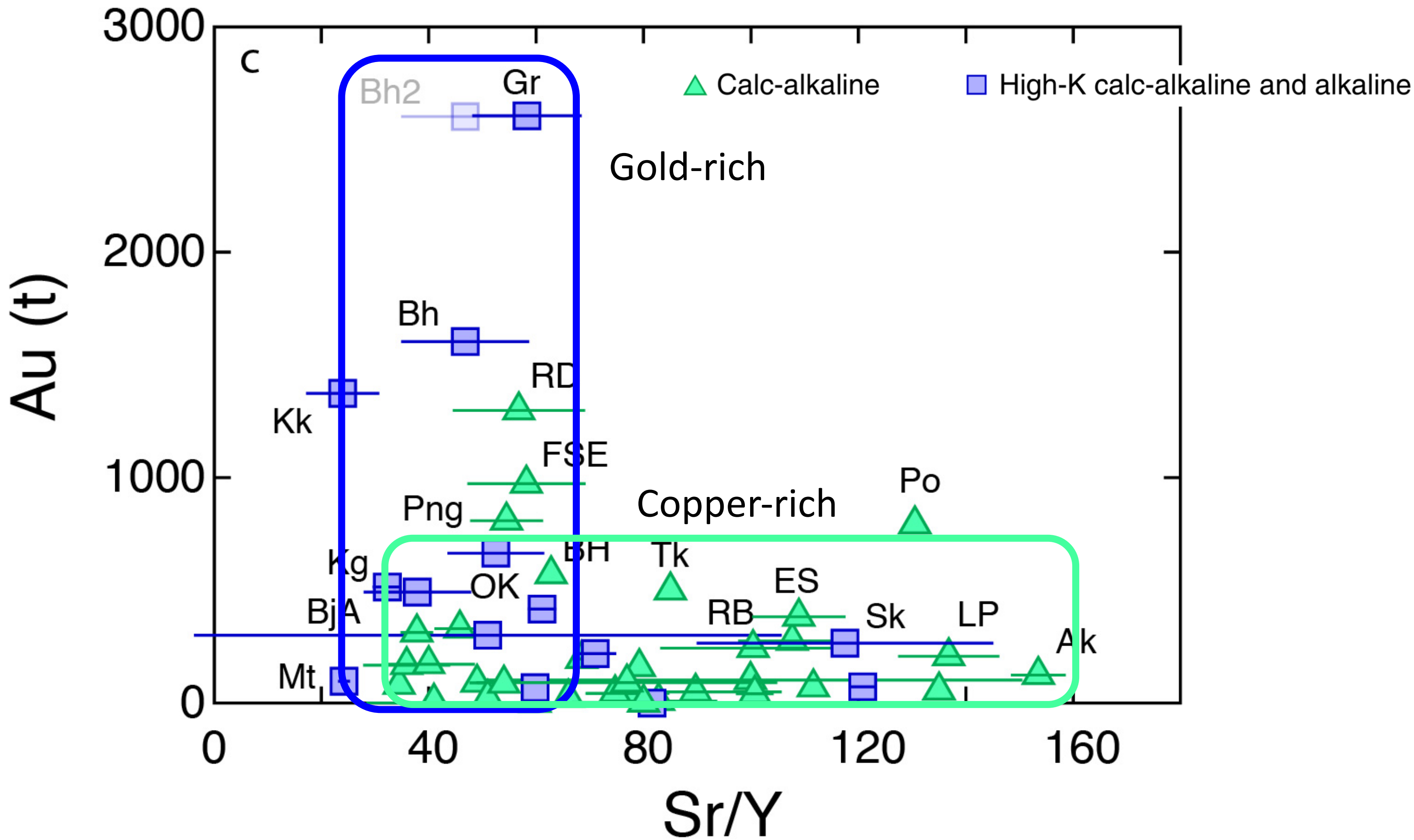


Cu-rich → calc-alkaline, thick crust, syn-subduction setting (Andean-type)

Au-rich → alkaline to cal-alkaline, thinner crust (island to transitional arcs), post-subduction to extension, but also calc-alkaline, thick crust, syn-subduction setting (Andean-type)

Chiaradia (2020) Gold endowments of porphyry deposits controlled by precipitation efficiency Nature Communications 11:248 | https://doi.org/10.1038/s41467-019-14113-1

Cu-rich versus Au-rich porphyries



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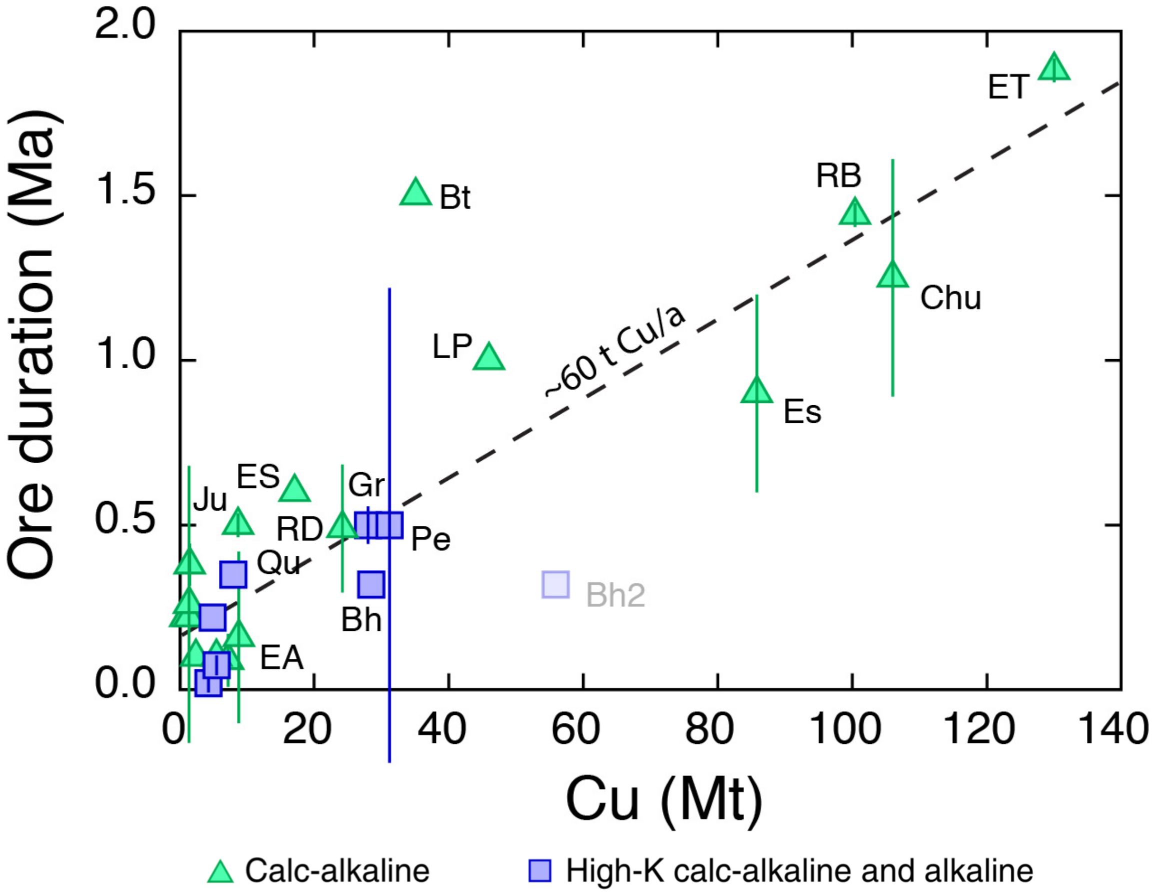
Cu endowment in Cu-rich versus Au-rich porphyries



Same Cu endowment controls in Cu-rich as in Au-rich porphyries (magma volume & ore process duration) → the difference concerns Au!

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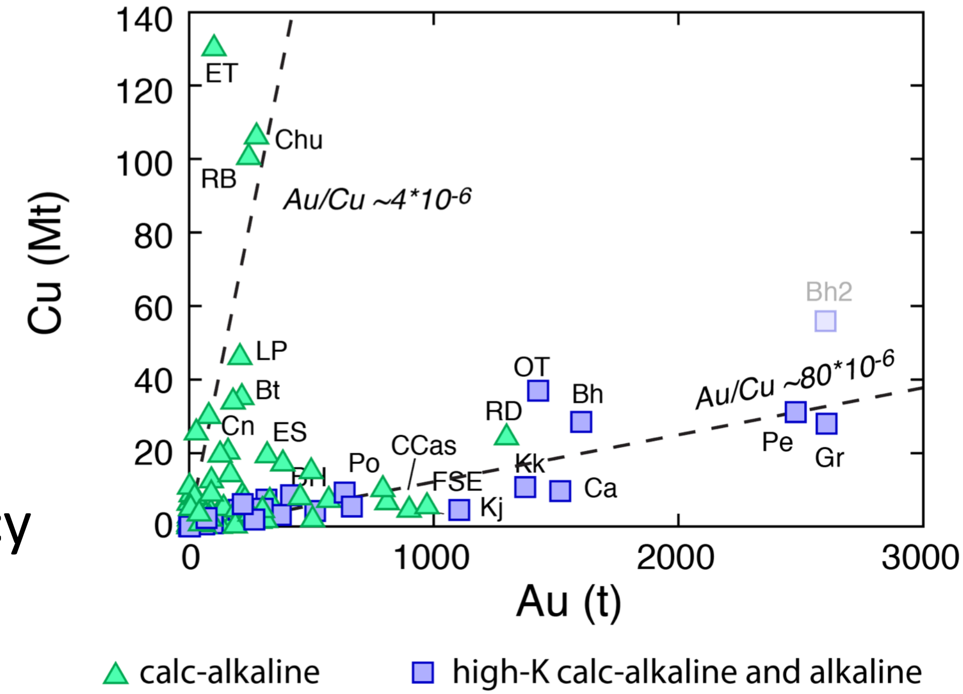
Cu-rich versus Au-rich porphyries: a petrogenetic control?

- Higher Au contents in alkaline than calc-alkaline magmas? (e.g., Rock and Groves, 1988)
- Higher fluid-melt ${}^{Au}K_D$ values in alkaline than in calc-alkaline magmas?
- Higher Au precipitation efficiency in alkaline than in calc-alkaline systems?



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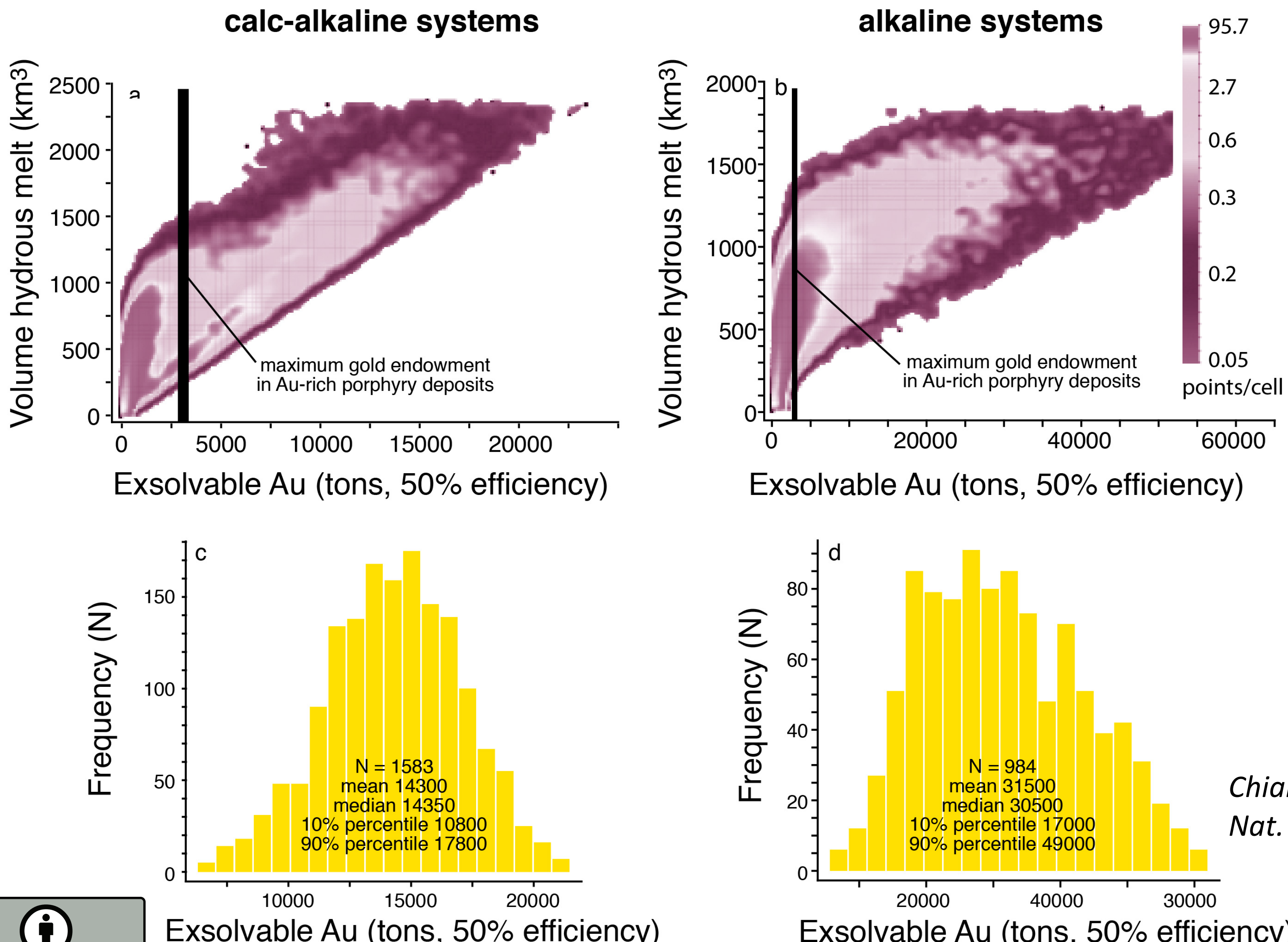
Higher Au contents in alkaline magmas?



Chiaradia (2020)
Nat. Comm.

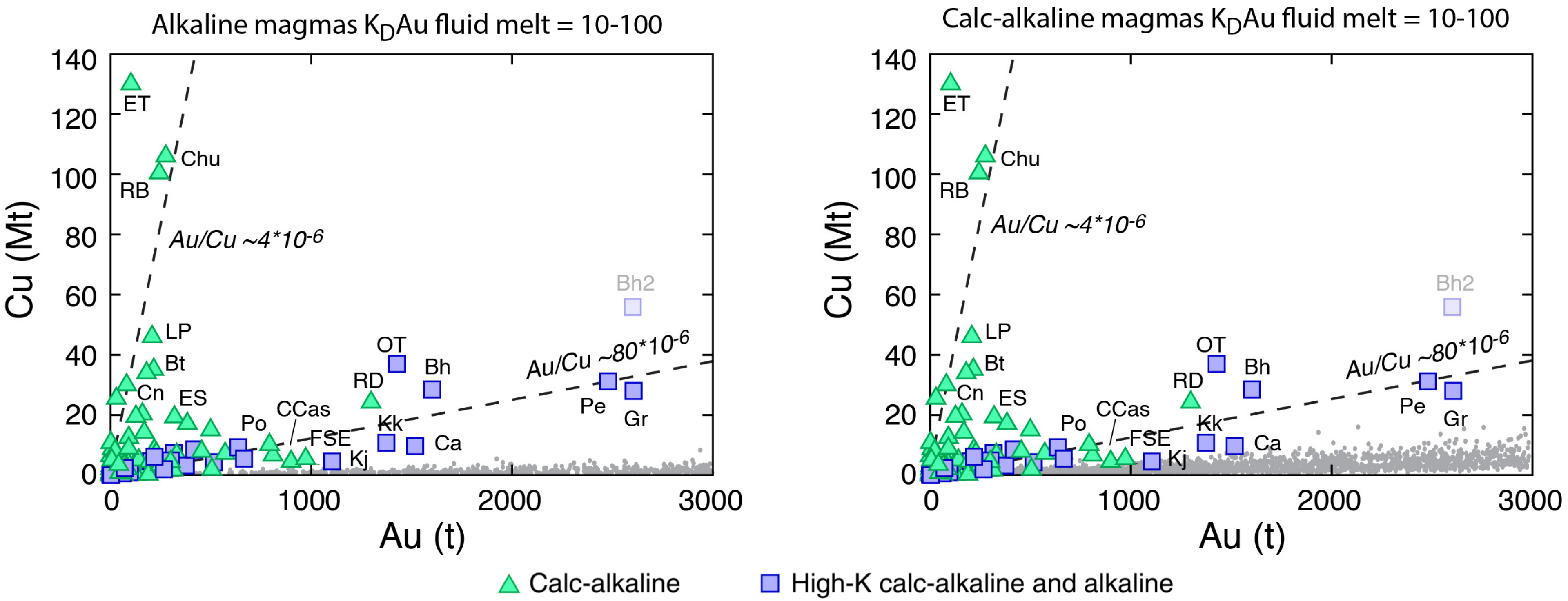
Cu-rich versus Au-rich porphyries: a petrogenetic control?

- ~~Higher Au contents in alkaline than calc-alkaline magmas? (e.g., Rock and Groves, 1988~~)

- Different fluid-melt $^{Au}K_D$ values in alkaline and calc-alkaline magmas?

- Higher precipitation efficiency in alkaline than in calc-alkaline systems?

Different fluid-melt $^{Au}K_D$ values in alkaline and calc-alkaline systems?



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K_D^{Cu} = 2-100

K_D^{Au} = 10-100

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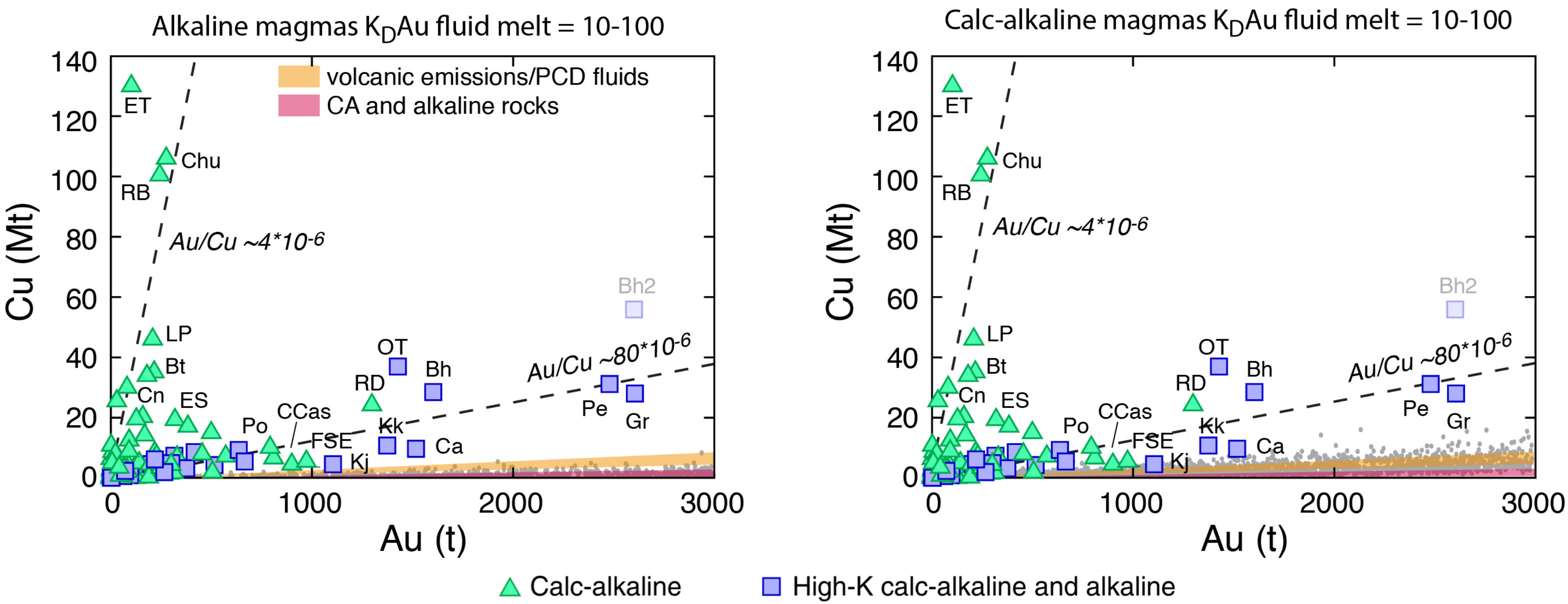
Different fluid-melt ${}^{Au}K_D$ values in alkaline and calc-alkaline systems?



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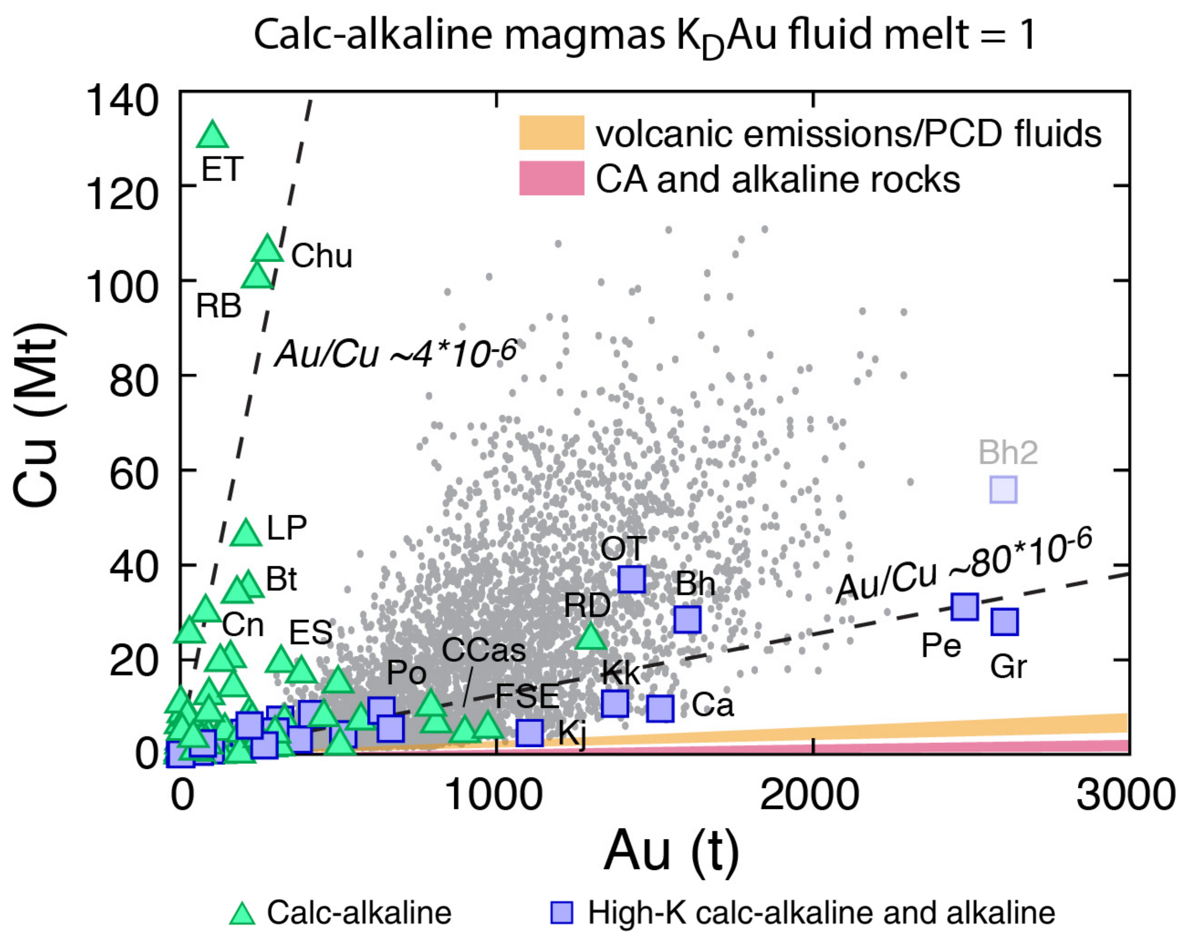

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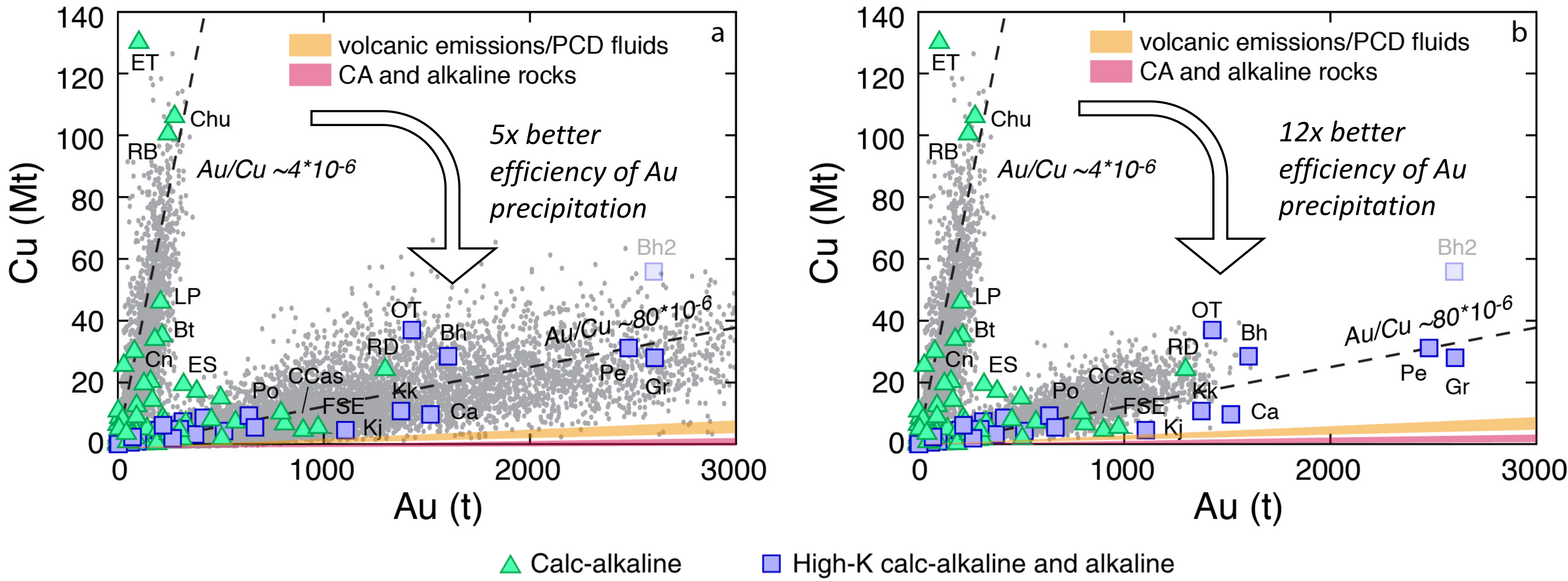
Cu versus Au precipitation efficiency



Au precipitation efficiency ~15 times better in Au-rich than in Cu-rich porphyry systems (in both cases Au precipitation efficiency is less than for Cu)

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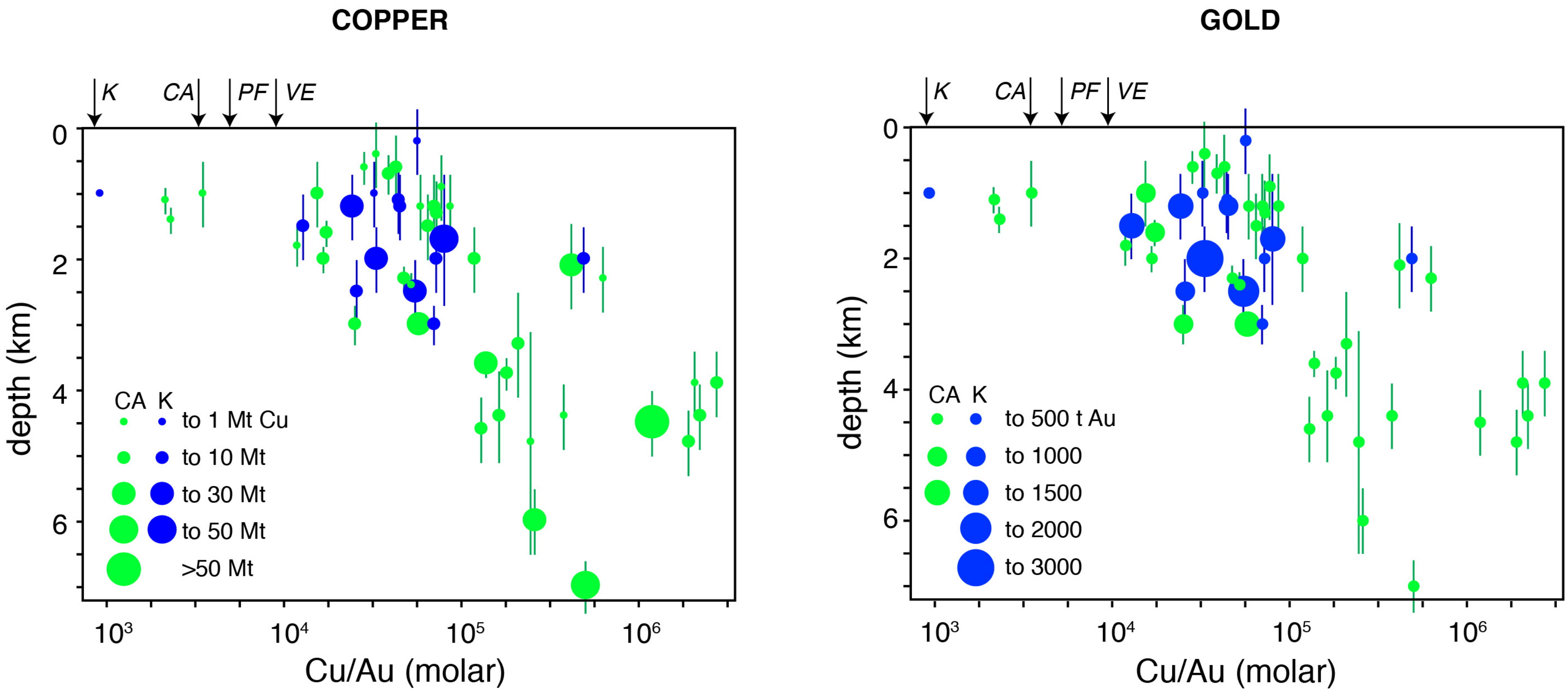
Cu-rich versus Au-rich porphyries: a petrogenetic control?

- ~~Higher Au contents in alkaline than calc-alkaline magmas? (e.g., Rock and Groves, 1988)~~

- ~~Different fluid-melt ${}^{Au}K_D$ values in alkaline and calc-alkaline magmas?~~

- Higher precipitation efficiency in alkaline than in calc-alkaline systems?

Cu versus Au precipitation efficiency: depth control?



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A tectonic control?

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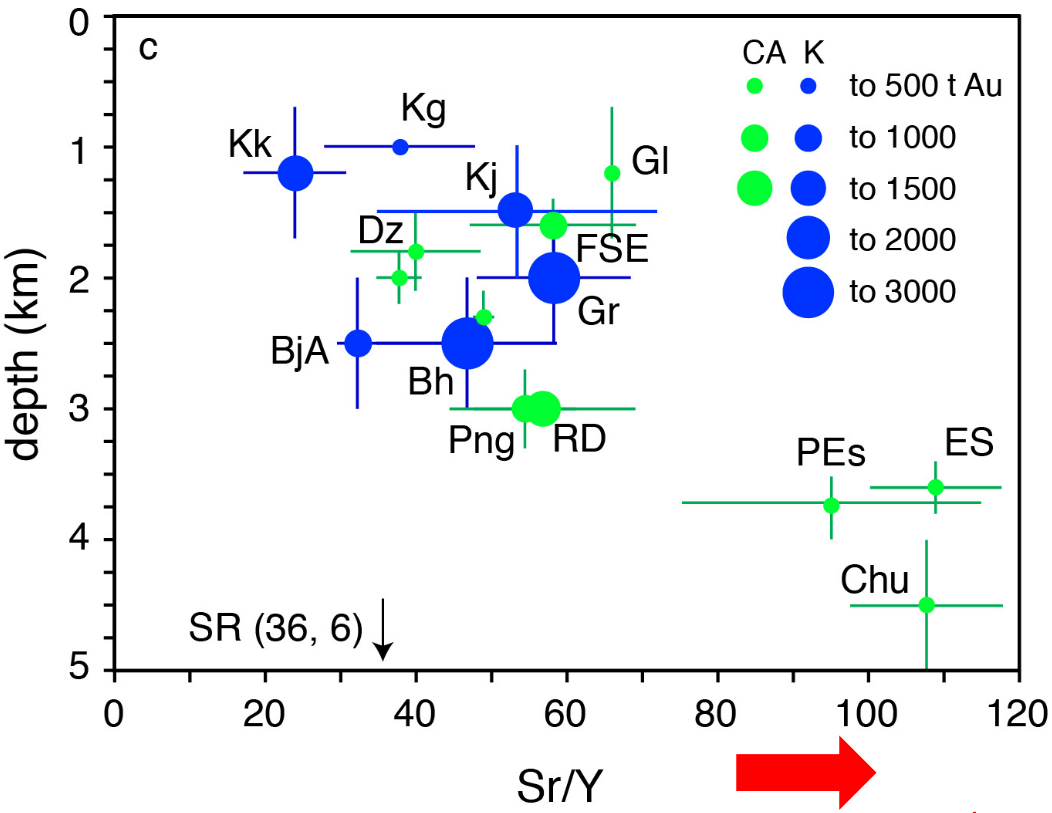
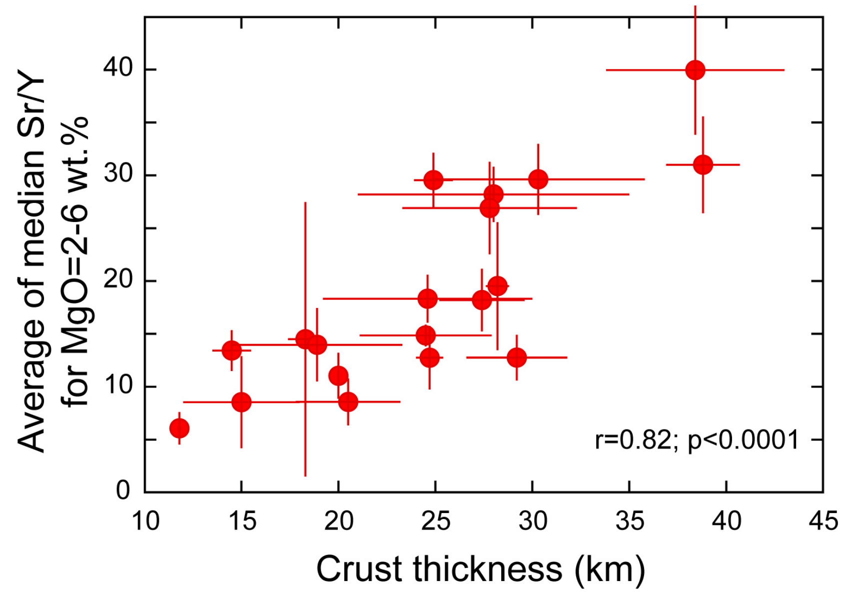


Increasing crustal thickness



Chiaradia (2015) Crustal thickness control on Sr/Y signatures of recent arc magmas: an Earth scale perspective. Scientific Reports 5 : 8115 | DOI: 10.1038/srep08115

Cu-rich versus Au-rich porphyries

Cu-rich porphyry deposits

- Build-up of large magmatic systems (1000-2000 km^3) at high pressure (>0.4 Gpa) and for long time (>2.5-3 Ma)
- Favoured by long-lasting compression during subduction in thick continental arcs
- Transfer of magma to upper crustal levels during timescales of ore-forming processes
- Multistage mineralization (0.0x-≤2 Ma): longer time = higher Cu tonnage

Au-rich porphyry deposits

- Increased Au precipitation efficiency → shallow depth and higher stability of gold complexes in magmatic fluids associated with alkaline rocks
- Favorable geodynamic setting (post-subduction, extension, island arcs → shallow depth)
- Multistage mineralization (0.0x-≤1 Ma): longer time = higher Au tonnage