

Crustal growth of the Cenozoic Central Andes from zircon trace and rare Earth element concentrations

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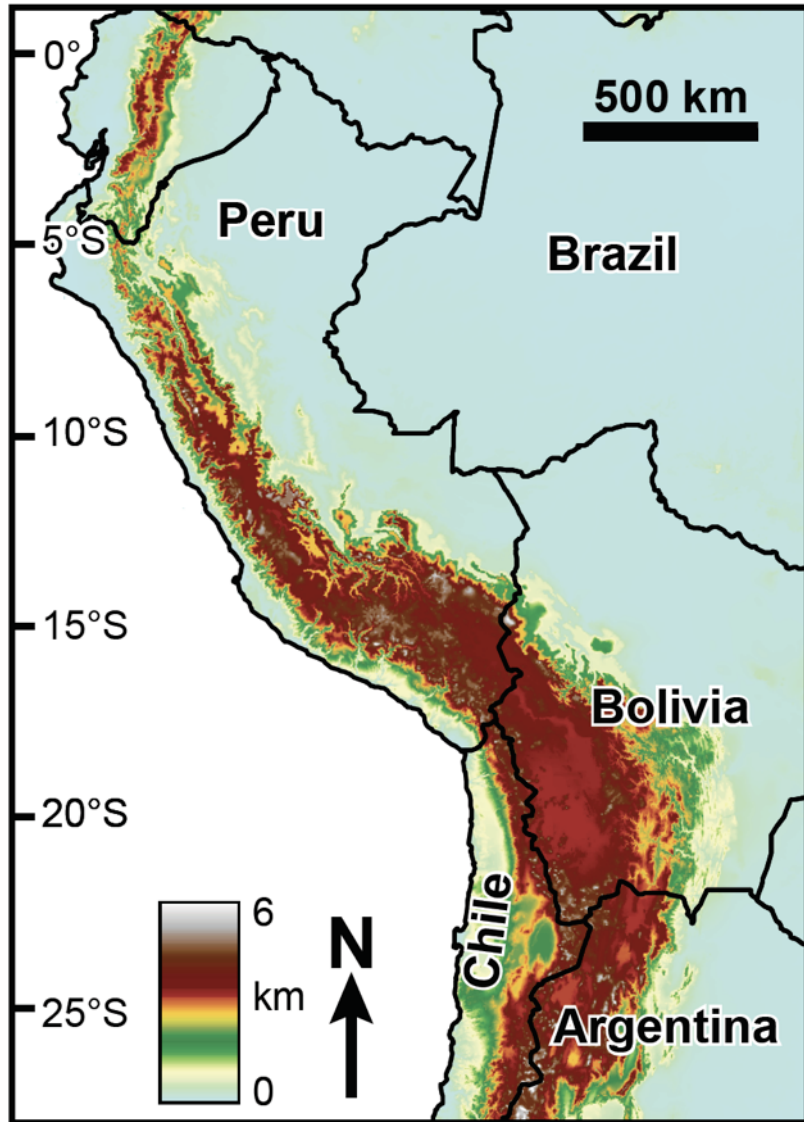
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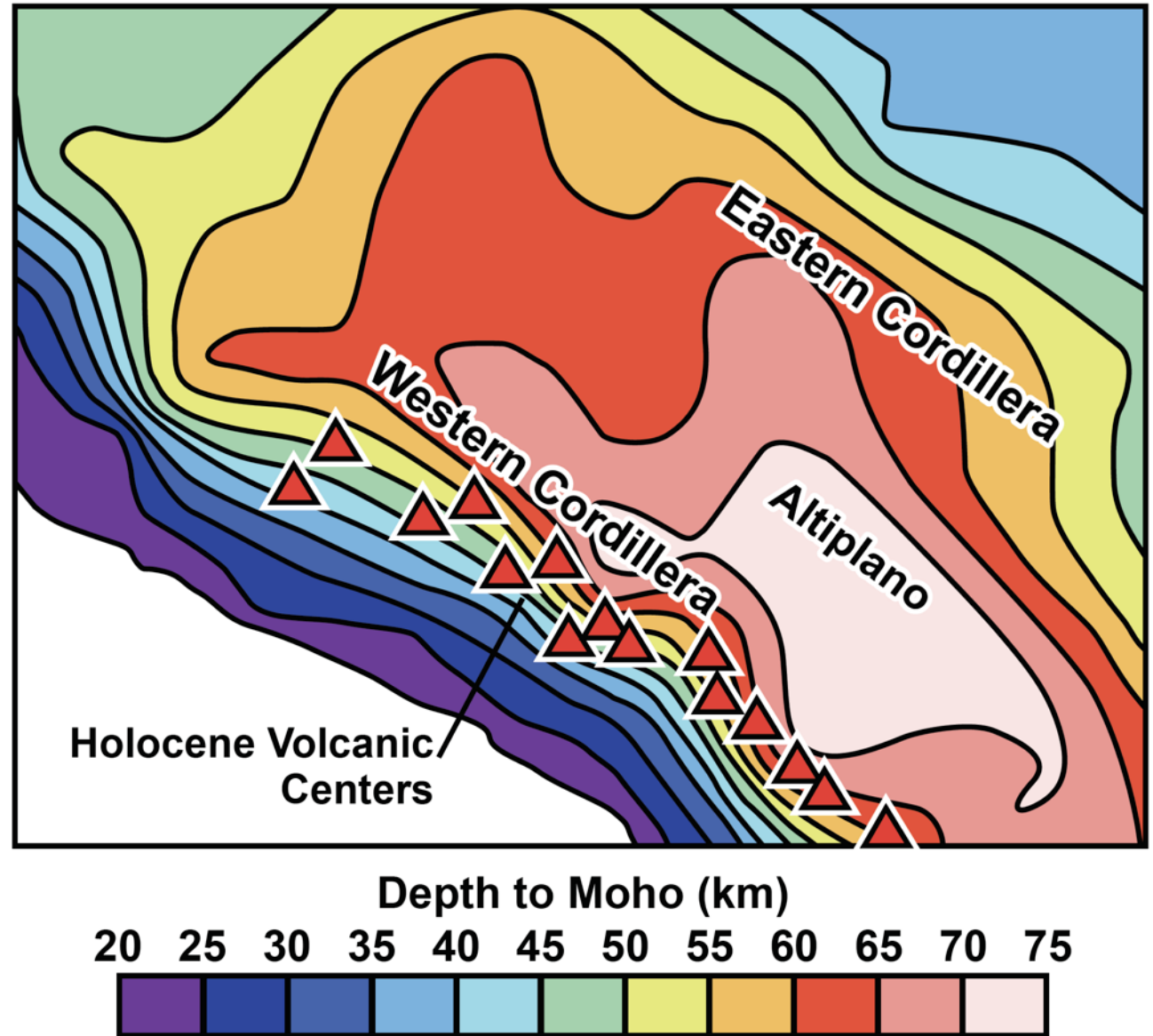
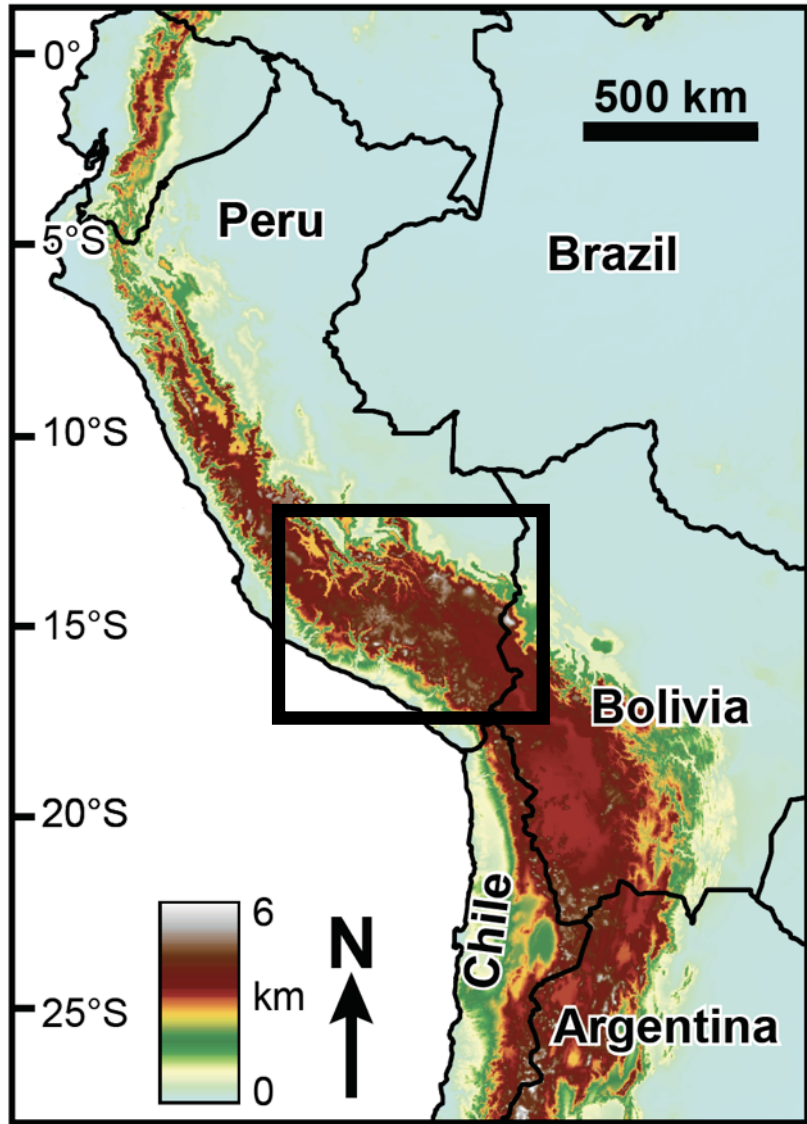
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Geologic Setting



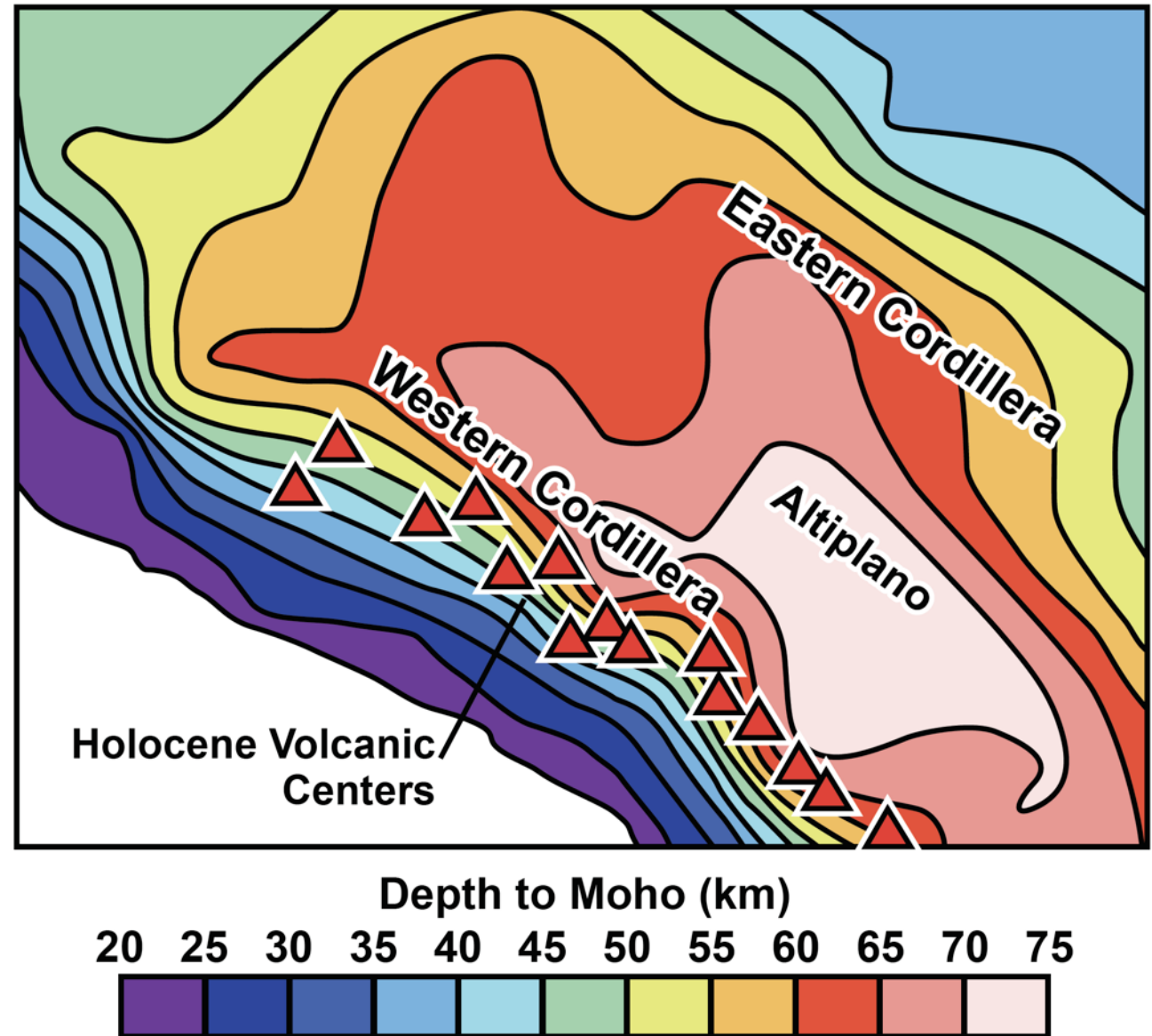
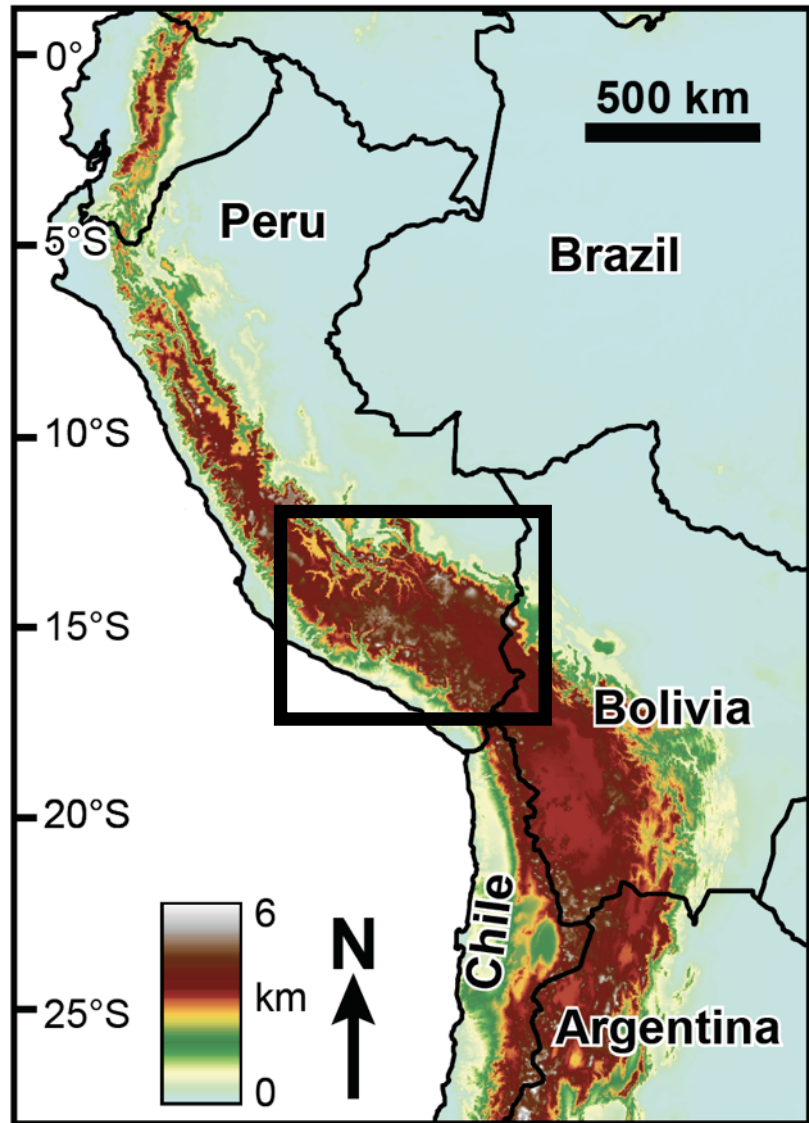
Motivation



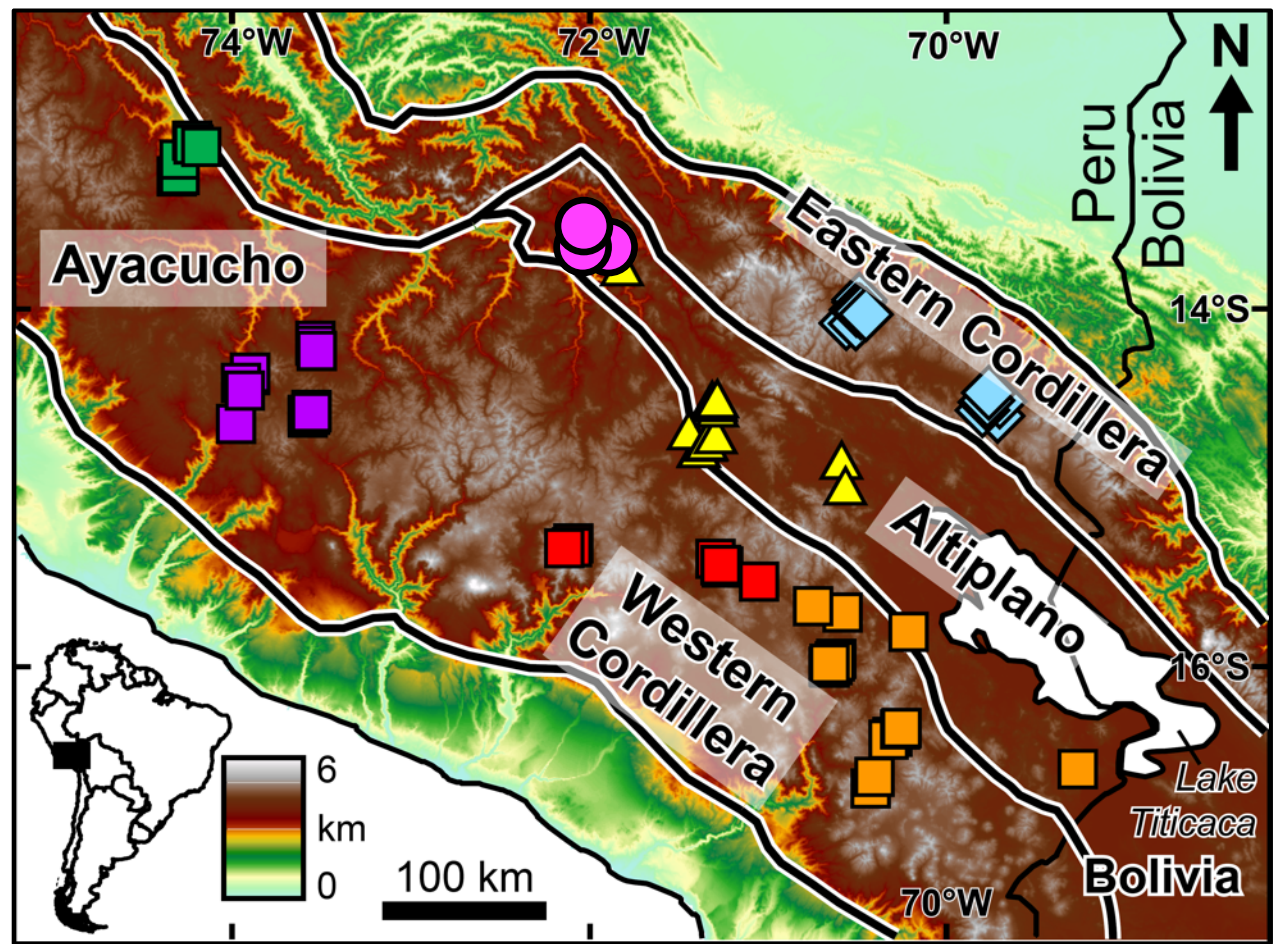
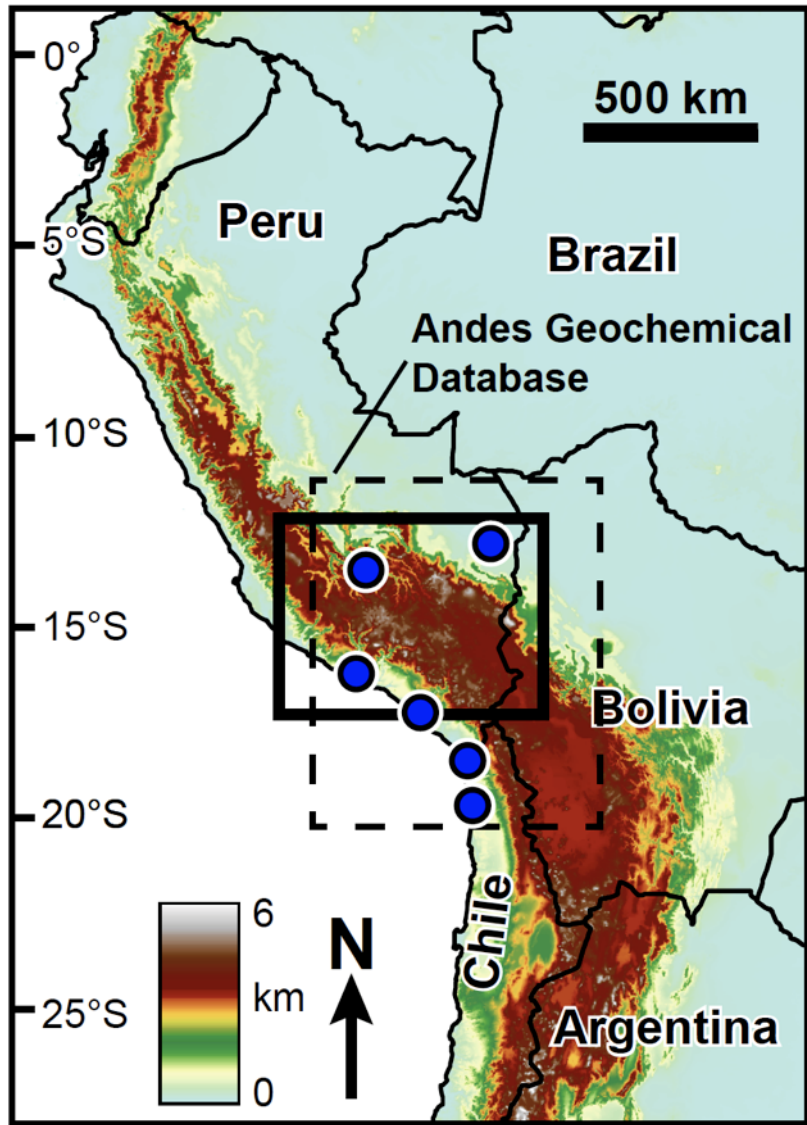
Motivation

What is the timing of crustal thickening?

What is its relationship to surface uplift and paleoclimate?

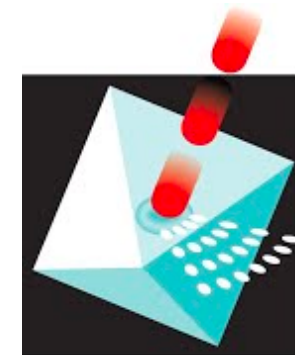
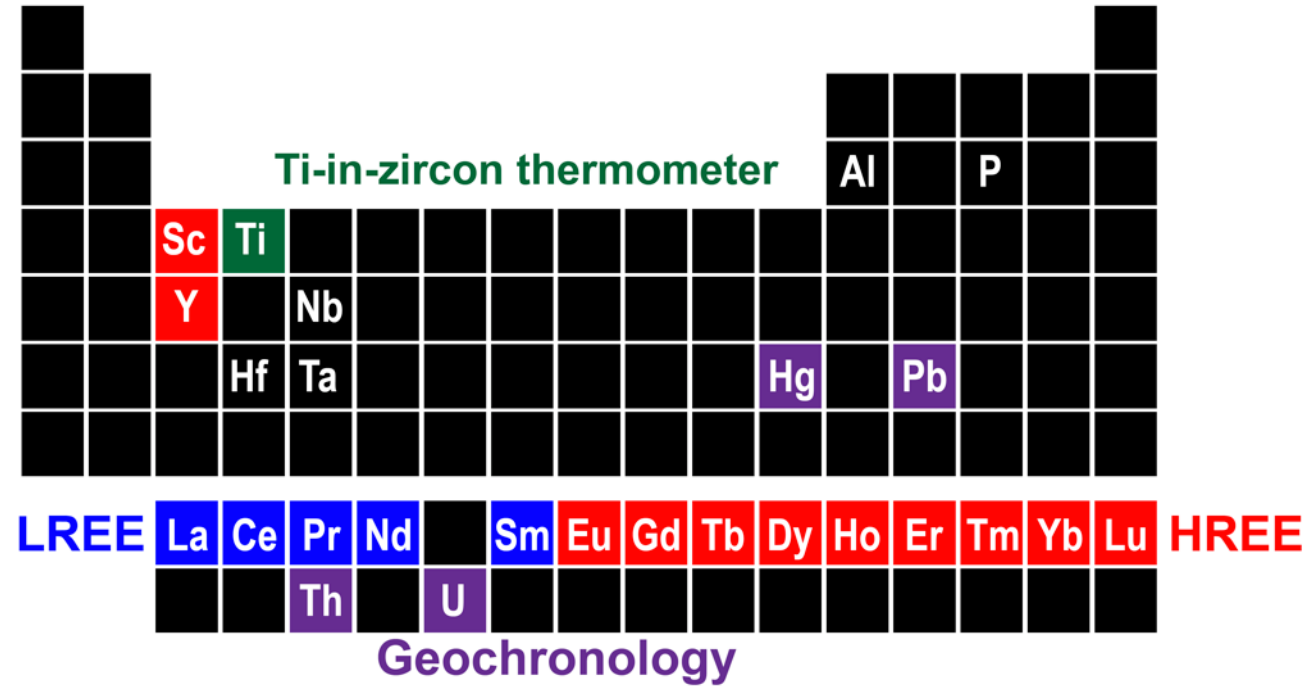
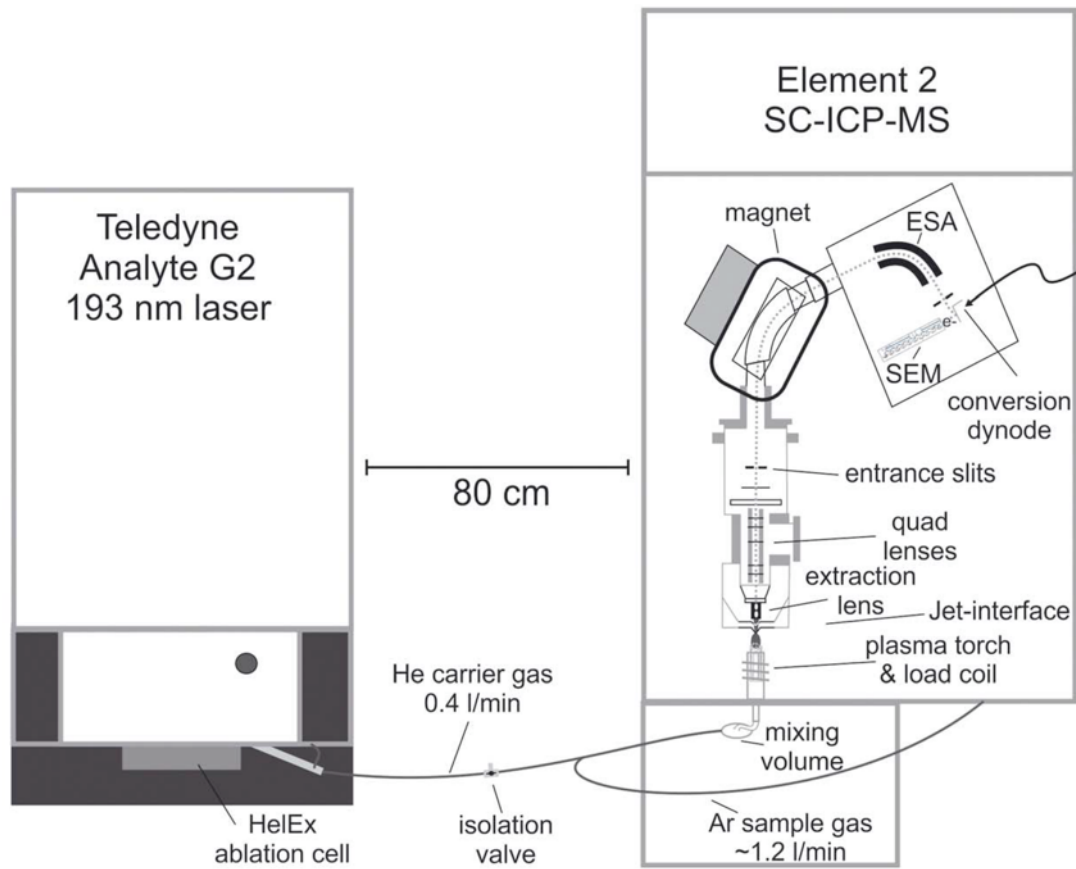


Zircon Samples



- Volcanic Rocks**
- Altiplano Sandstones**
- Modern Rivers** (Pepper et al., 2016)

Methods – LA-ICPMS

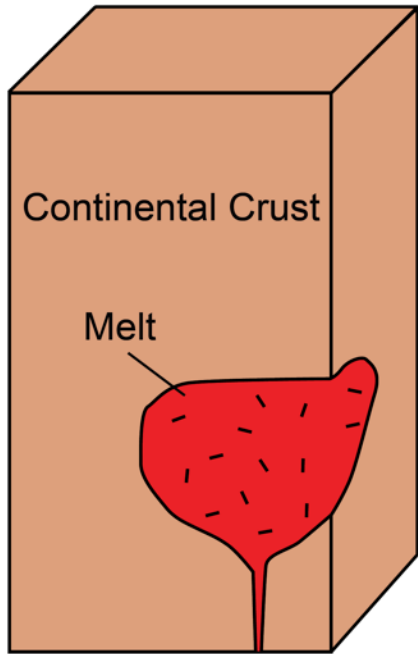


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Magma Chemistry

LREE La Ce Pr Nd Sm Eu Gd Tb Dy Ho Er Tm Yb Lu HREE

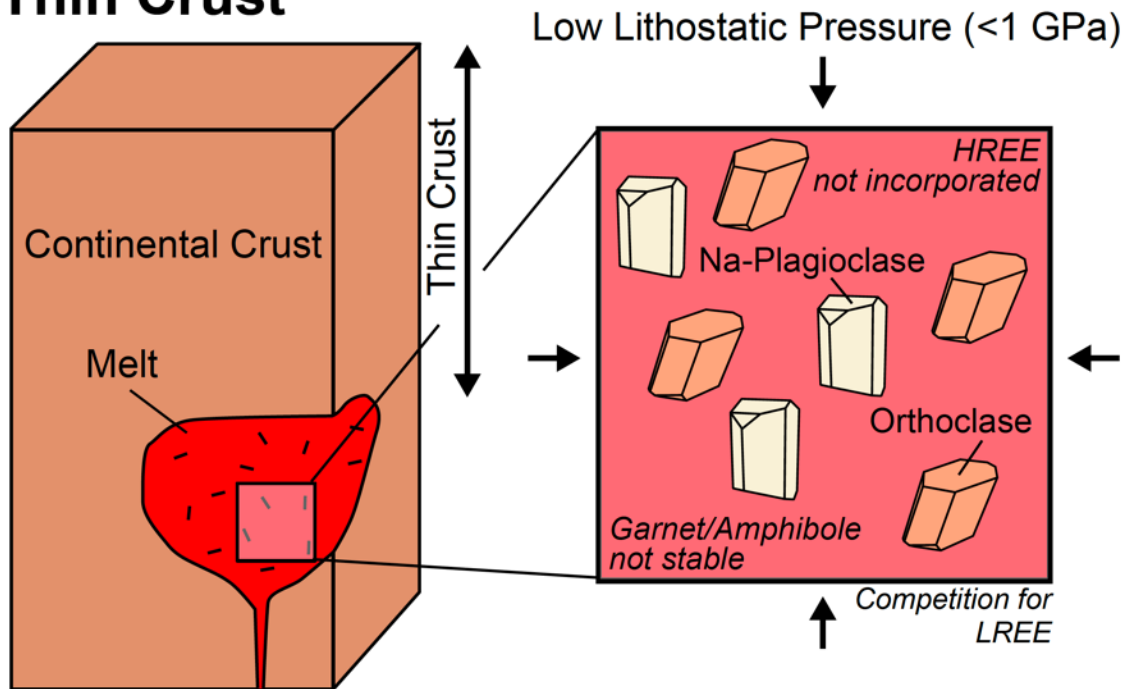


Magma Chemistry

LREE La Ce Pr Nd Sm Eu Gd Tb Dy Ho Er Tm Yb Lu HREE

$$\frac{\sum LREE}{\sum HREE}, \frac{La}{Yb}, \frac{Sm}{Yb} \downarrow$$

Thin Crust

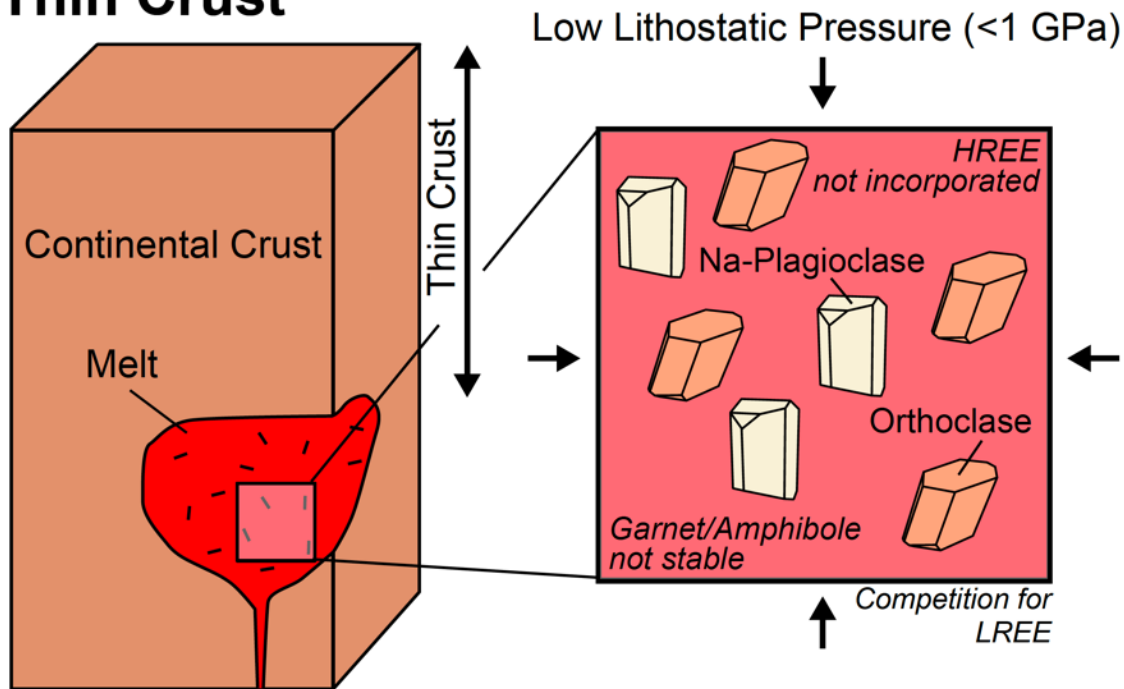


Magma Chemistry

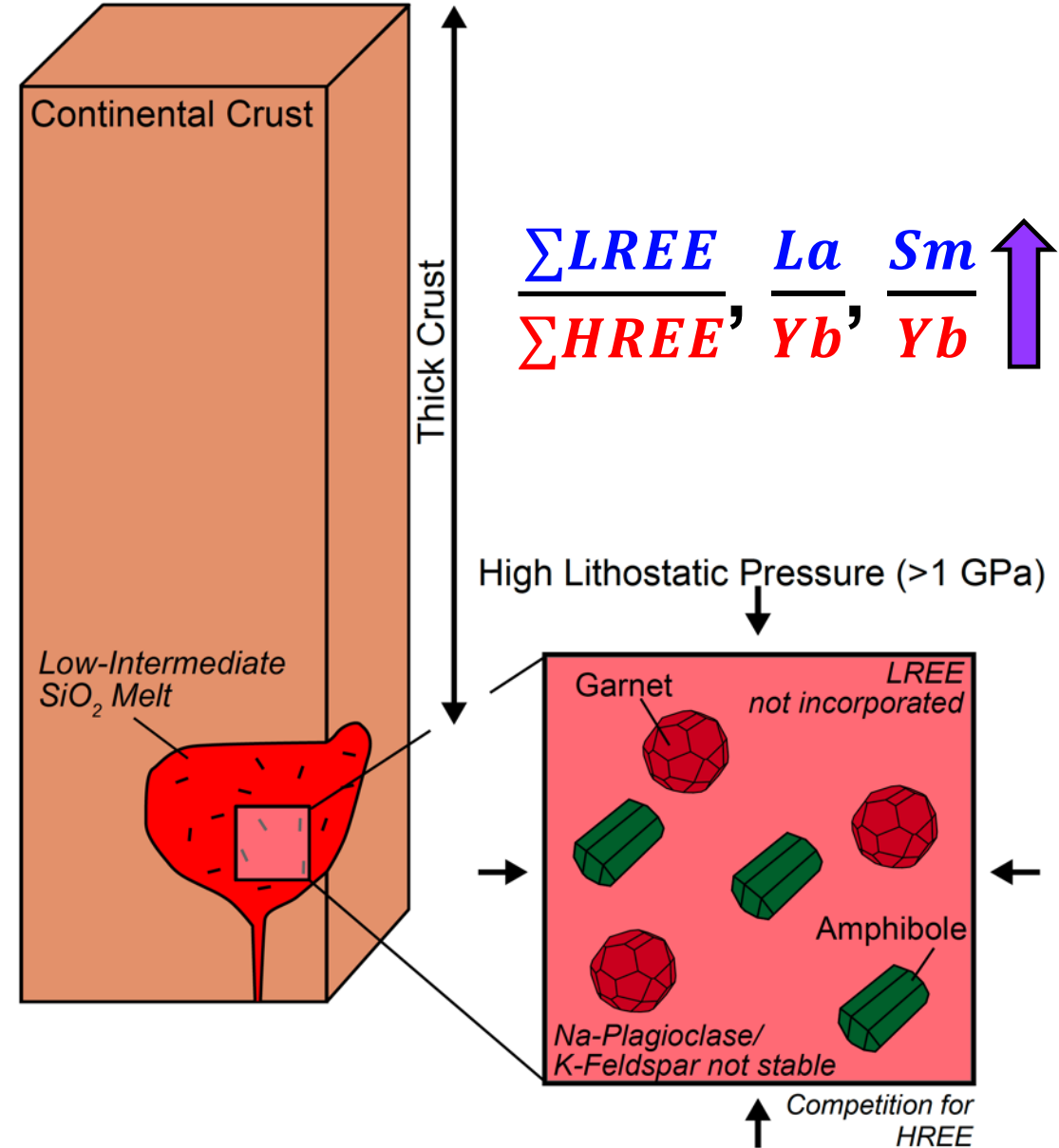
LREE | La | Ce | Pr | Nd | | Sm | Eu | Gd | Tb | Dy | Ho | Er | Tm | Yb | Lu | HREE

$$\frac{\sum LREE}{\sum HREE}, \frac{La}{Yb}, \frac{Sm}{Yb} \downarrow$$

Thin Crust



Thick Crust

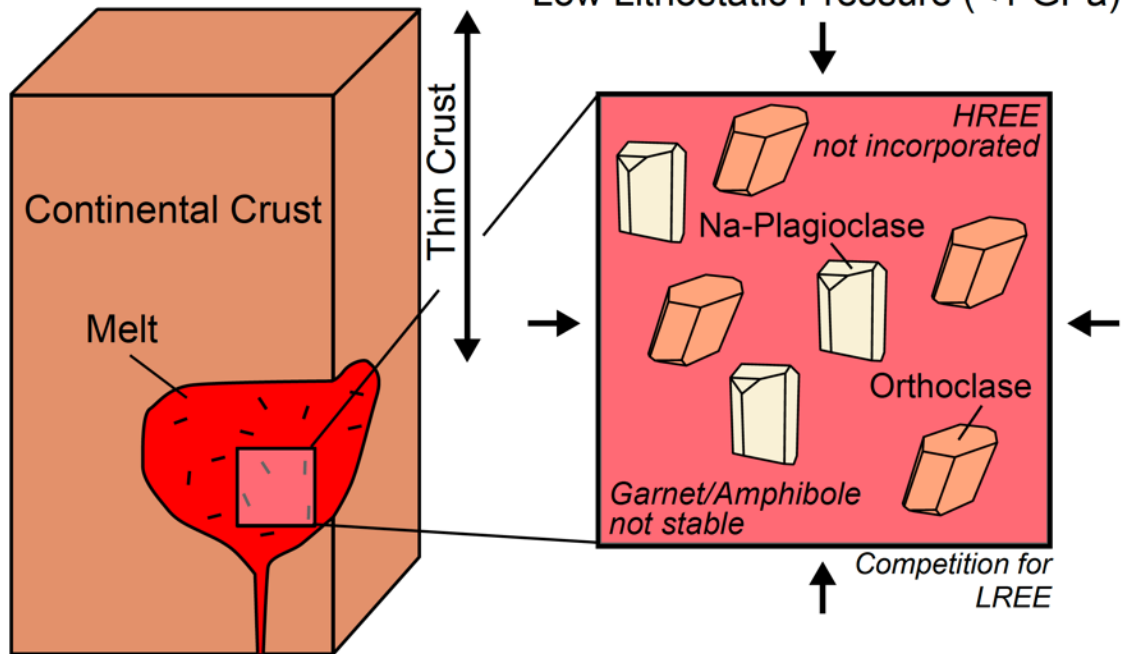


Magma Chemistry

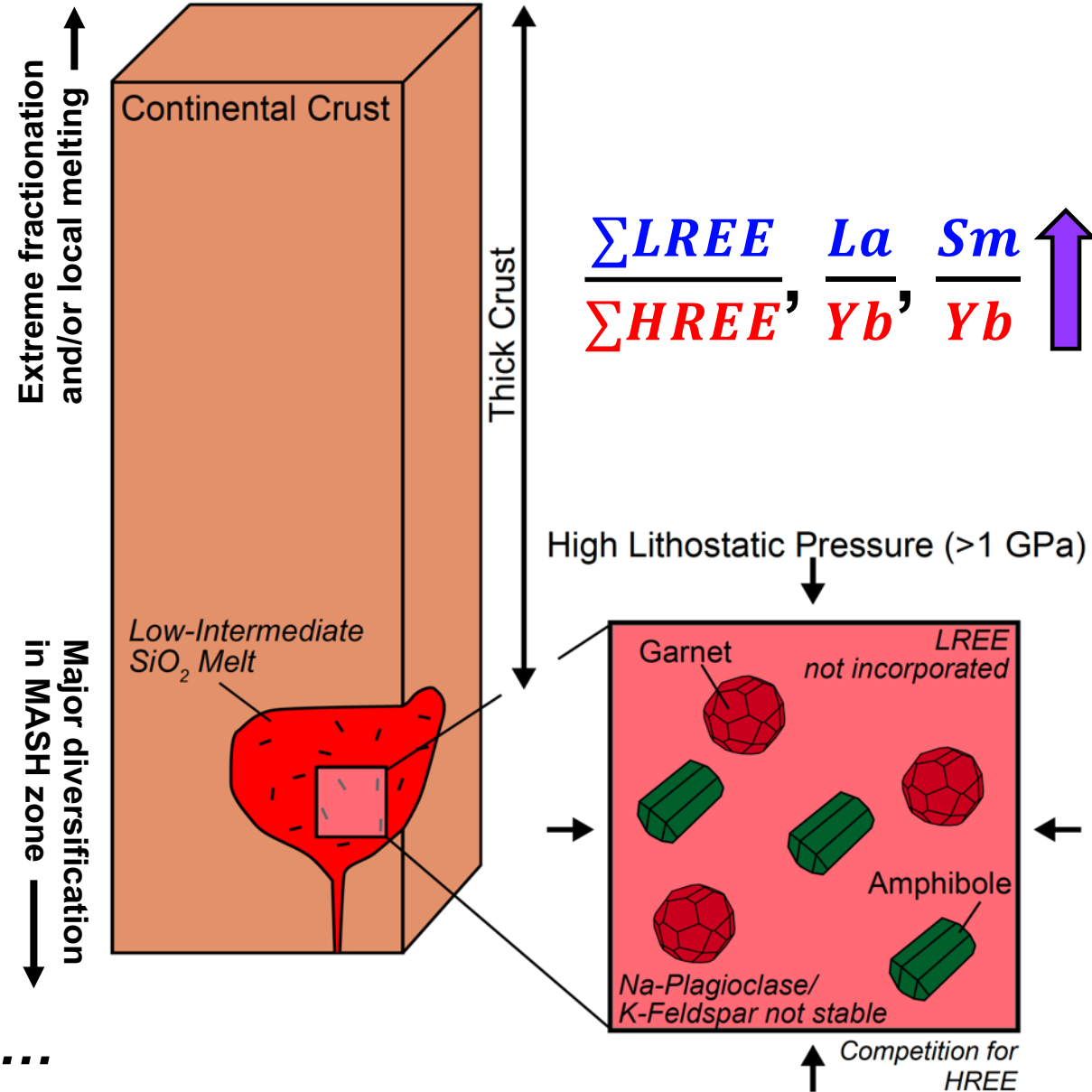
LREE La Ce Pr Nd Sm Eu Gd Tb Dy Ho Er Tm Yb Lu HREE

$$\frac{\sum LREE}{\sum HREE}, \frac{La}{Yb}, \frac{Sm}{Yb} \downarrow$$

Thin Crust

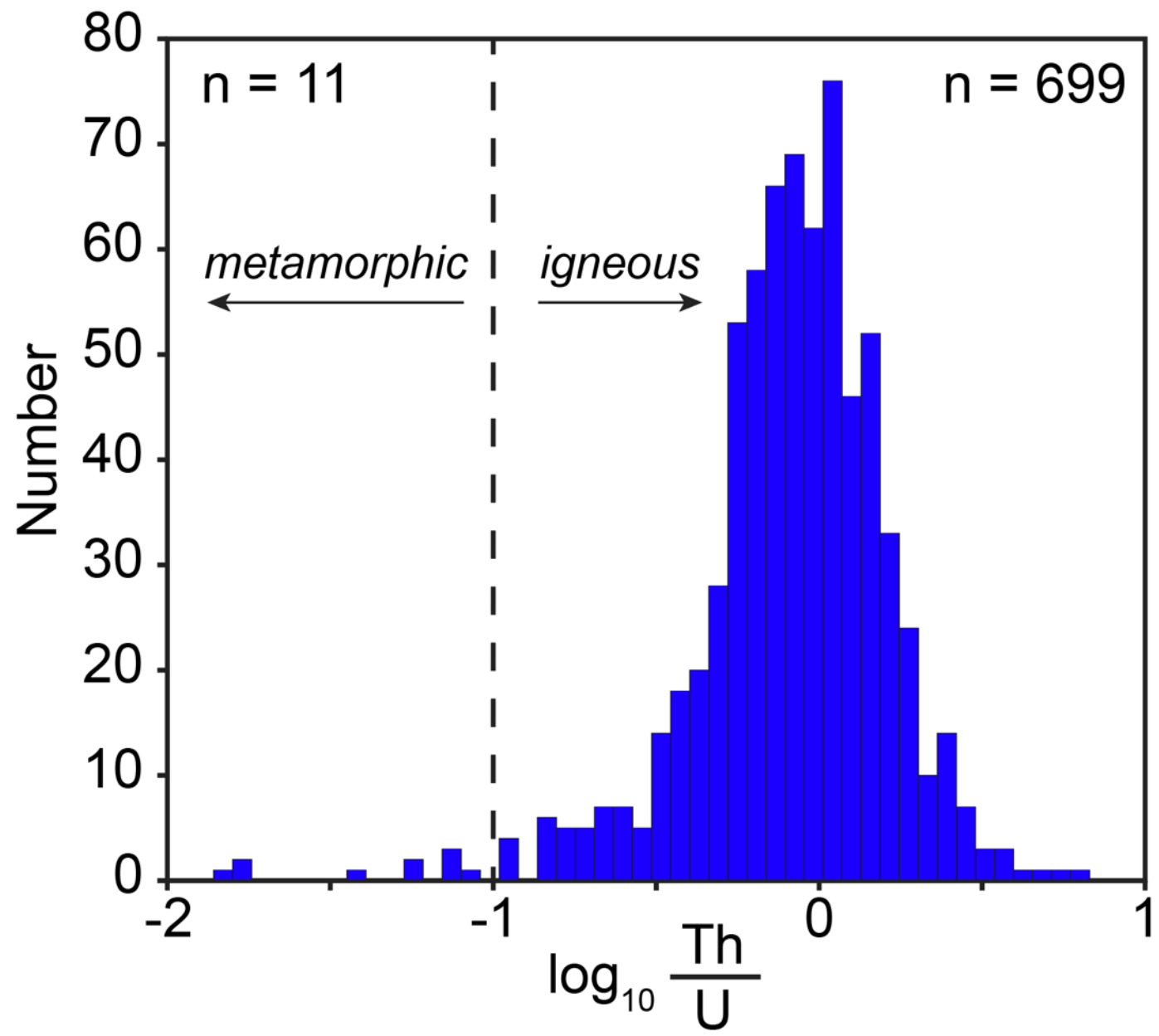


Thick Crust



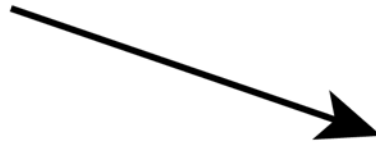
Works best for 60–70% SiO₂ igneous rocks...

Igneous Zircon



Supervised Machine Learning

Known Data



Model

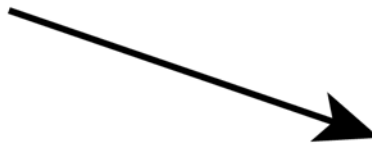
Known Responses



Supervised Machine Learning

Zircon Trace Element
Concentrations

Known Data

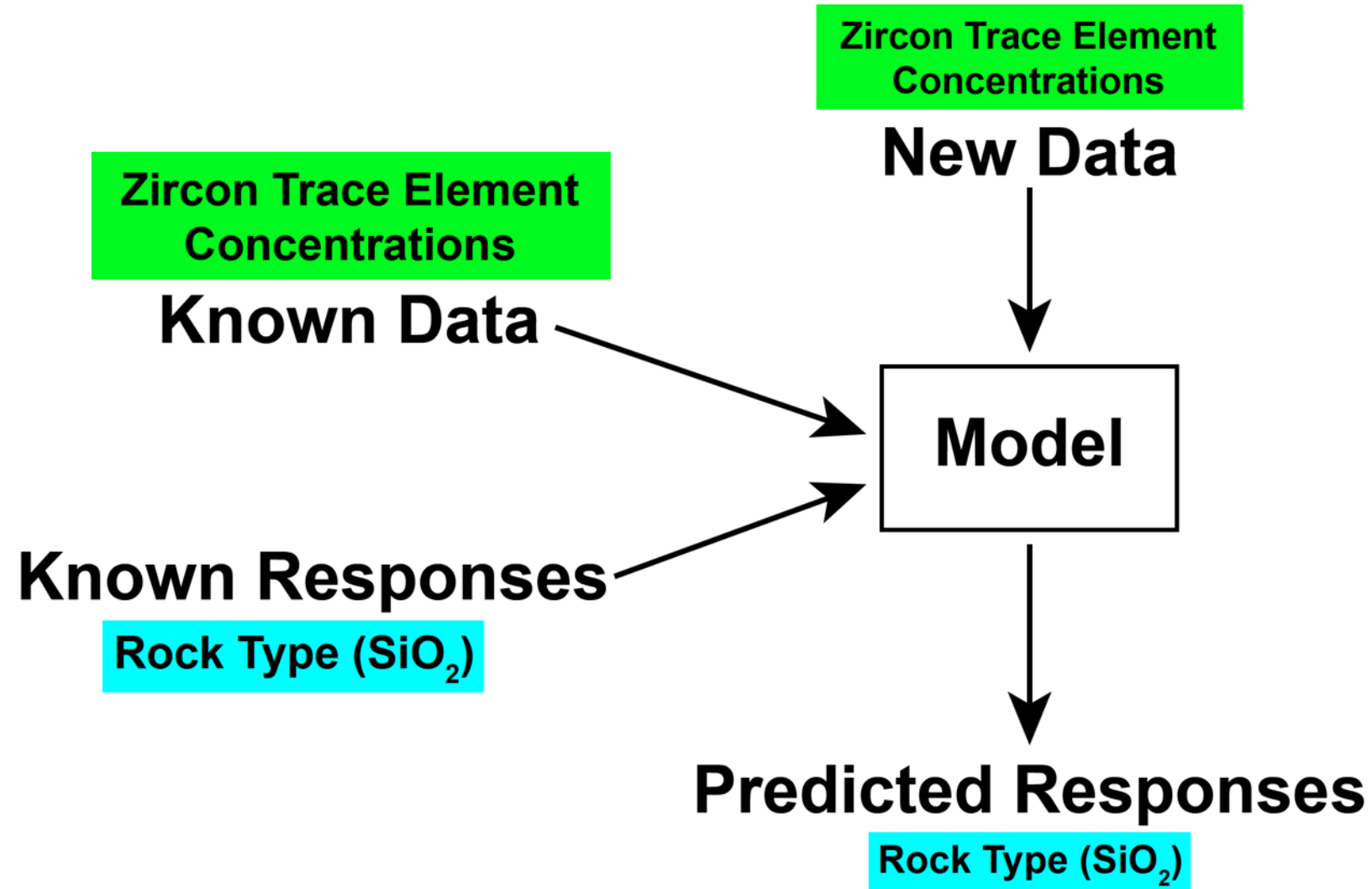


Known Responses

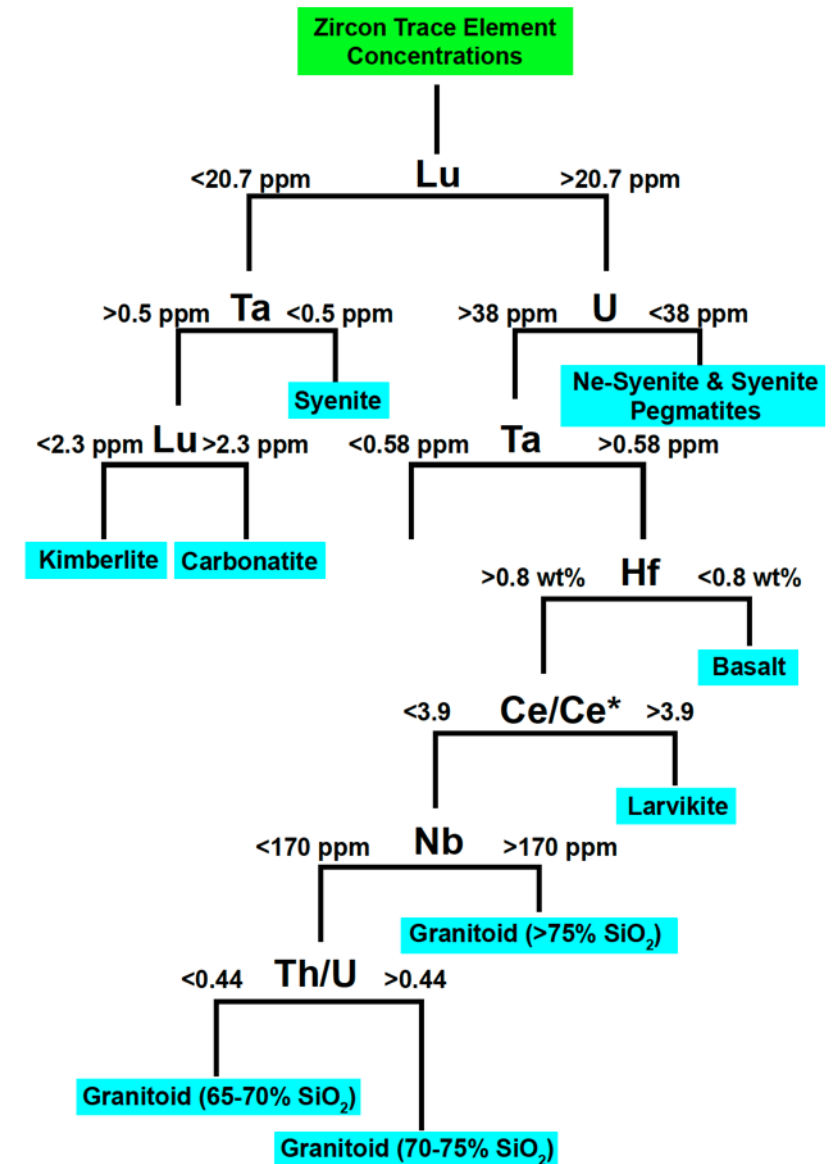
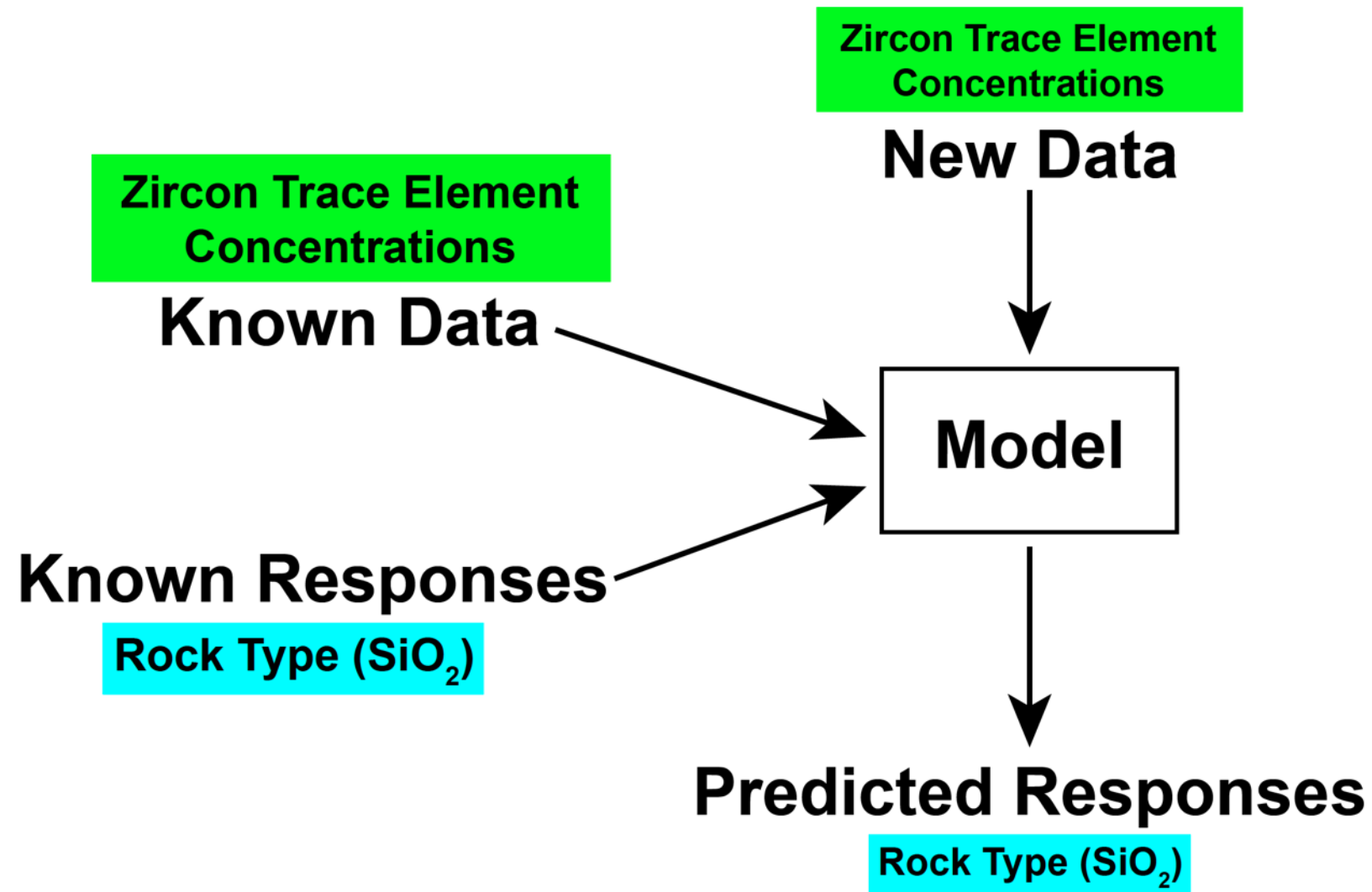
Rock Type (SiO₂)



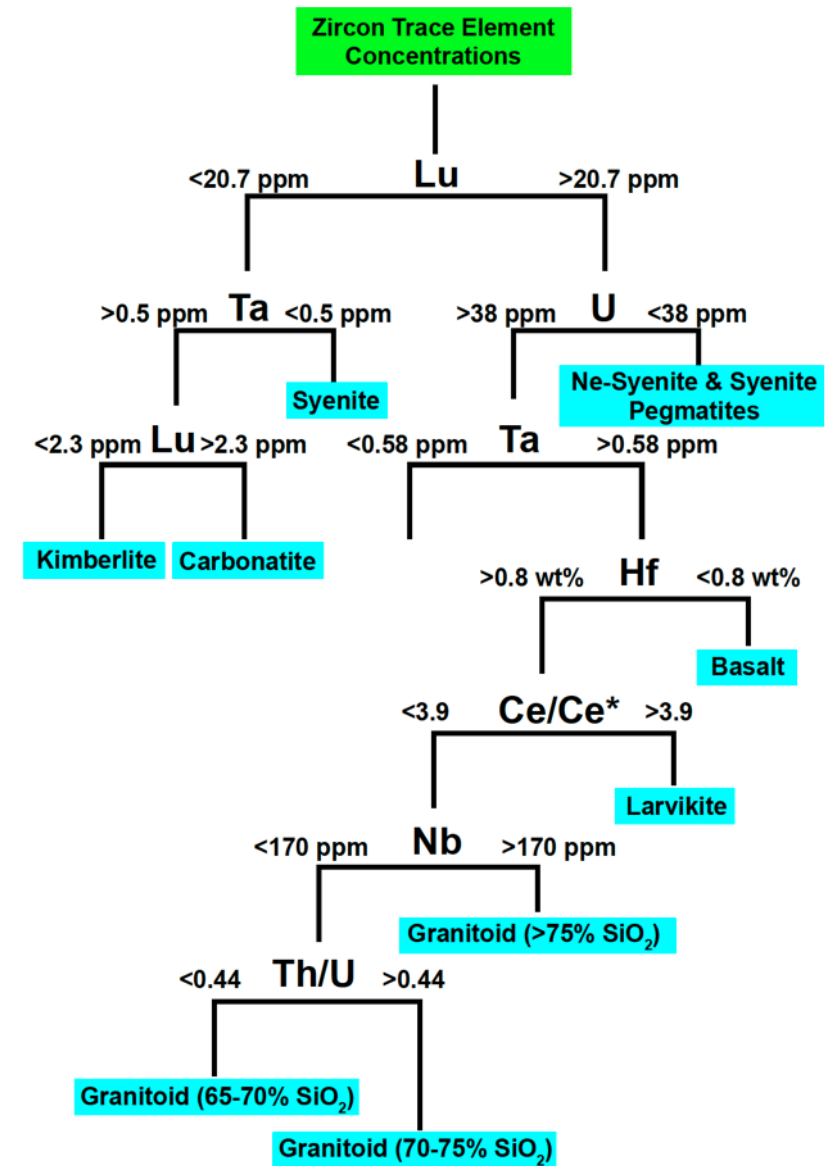
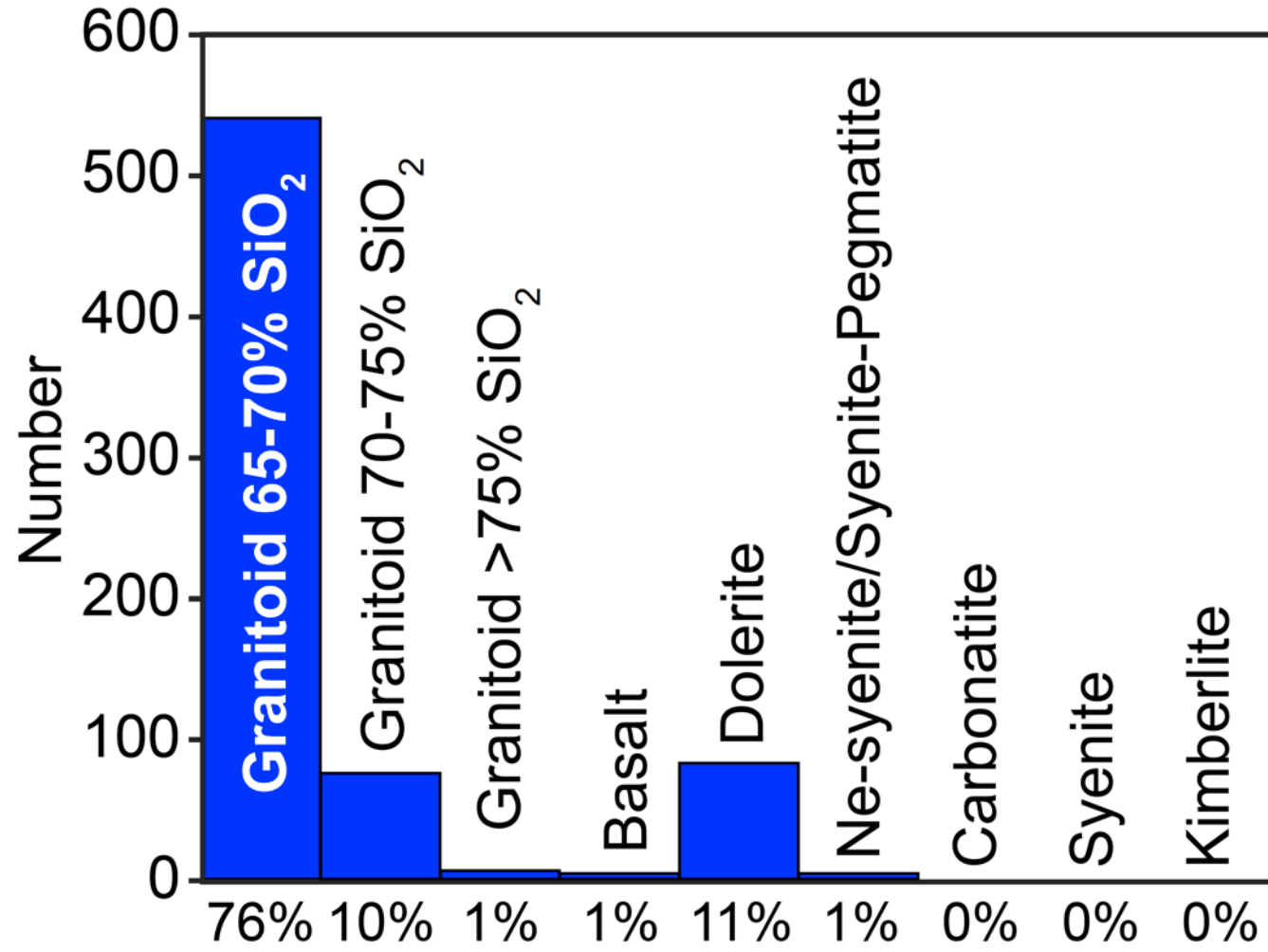
Supervised Machine Learning



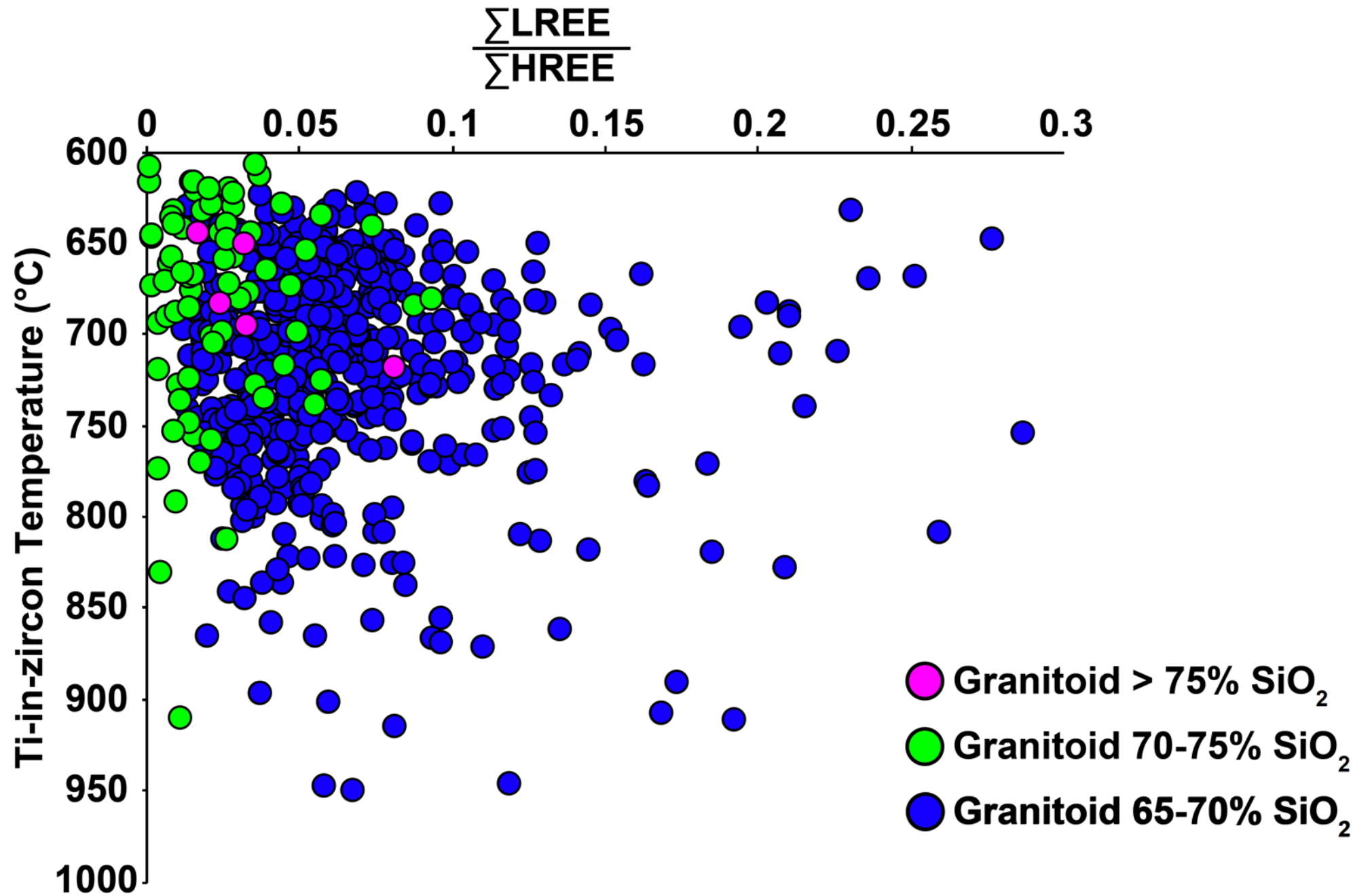
Supervised Machine Learning



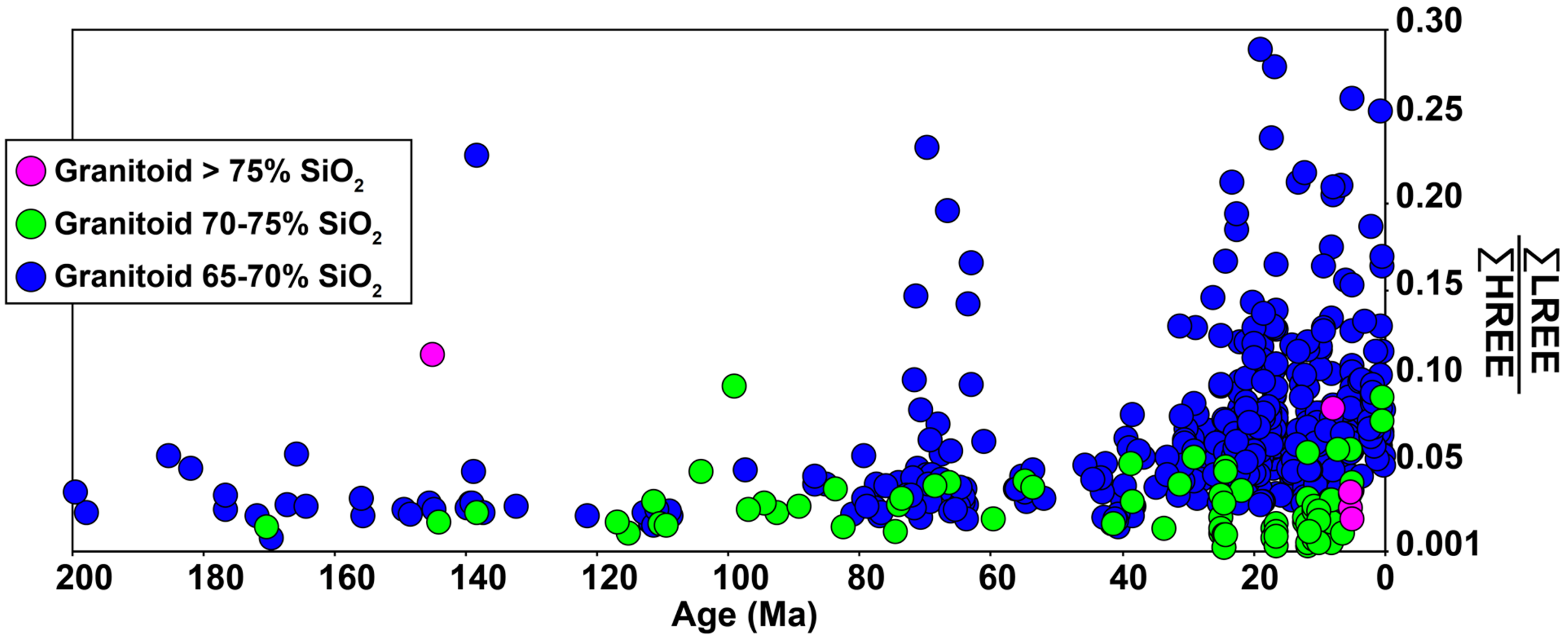
Predicted Responses (Rock Type)



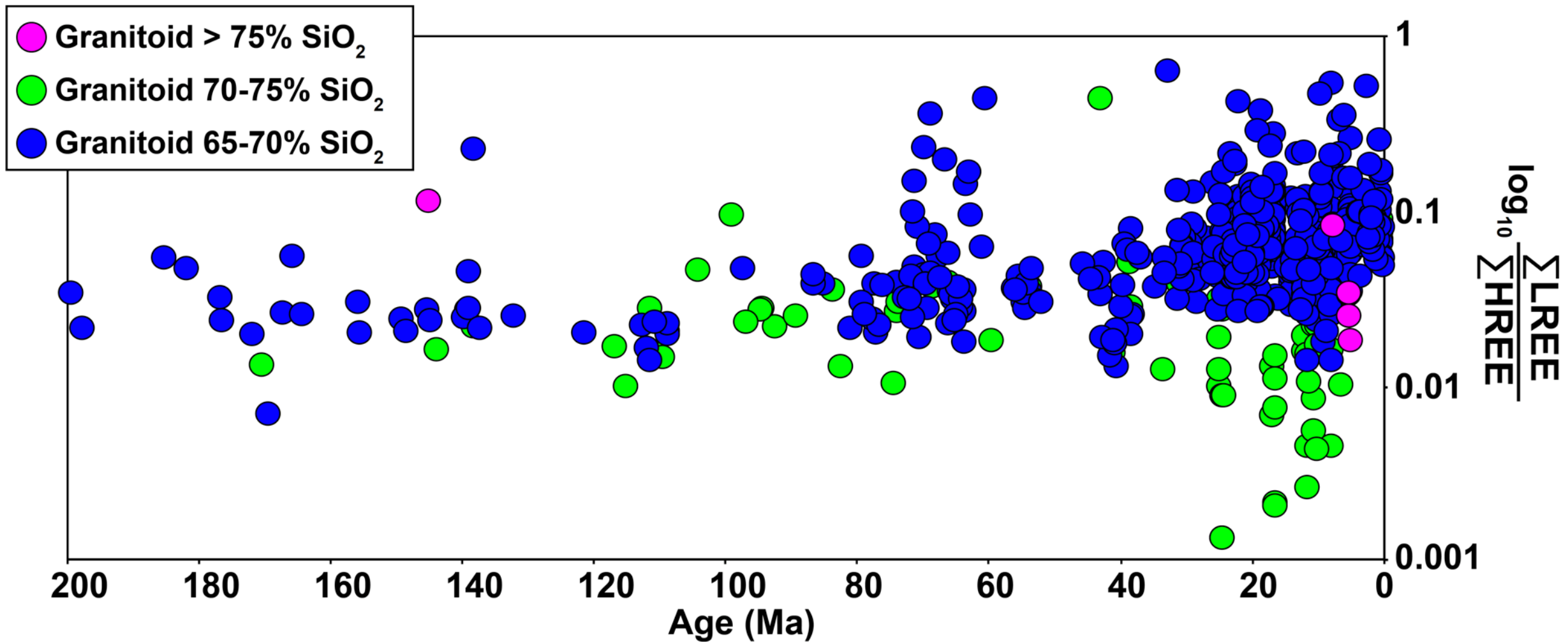
Granitoids



Results Σ LREE/ Σ HREE

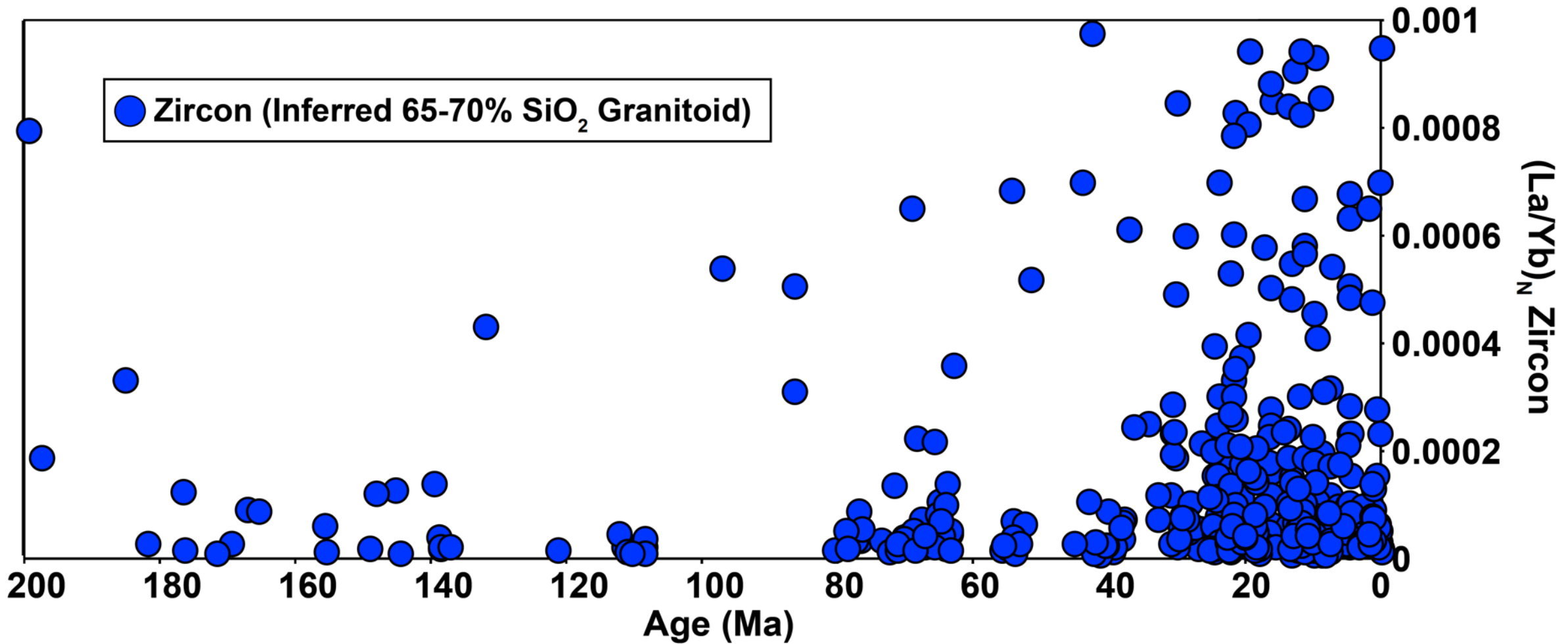


Results Σ LREE/ Σ HREE



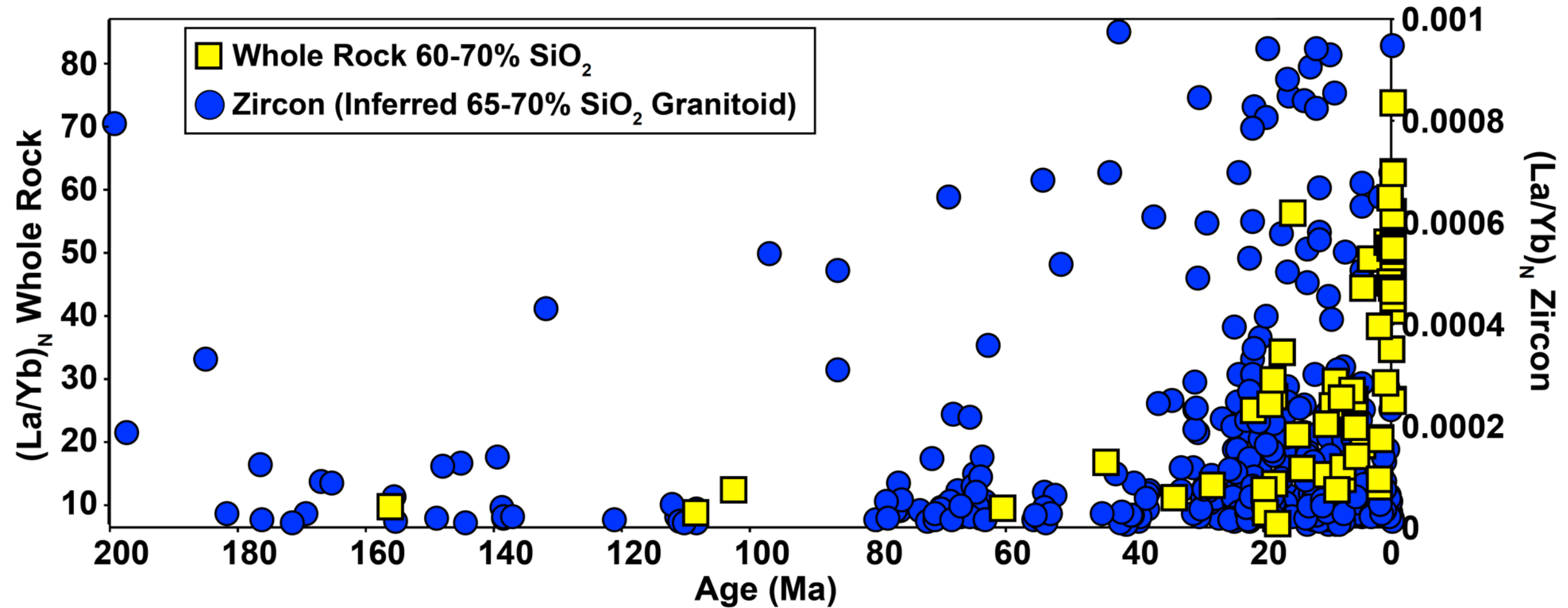
Results (La/Yb)_N

LREE **La** **Ce** **Pr** **Nd** **Sm** **Eu** **Gd** **Tb** **Dy** **Ho** **Er** **Tm** **Yb** **Lu** HREE



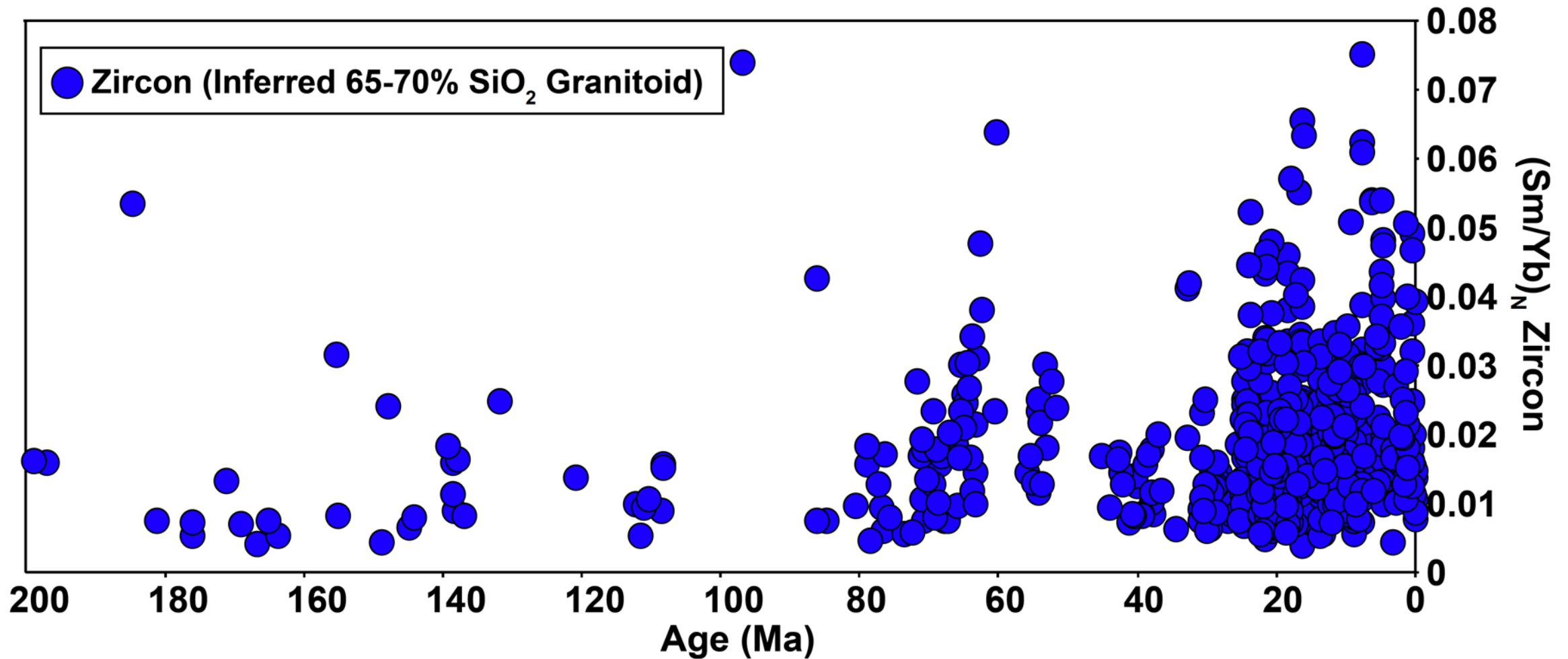
Results $(La/Yb)_N$

LREE La Ce Pr Nd Sm Eu Gd Tb Dy Ho Er Tm Yb Lu HREE



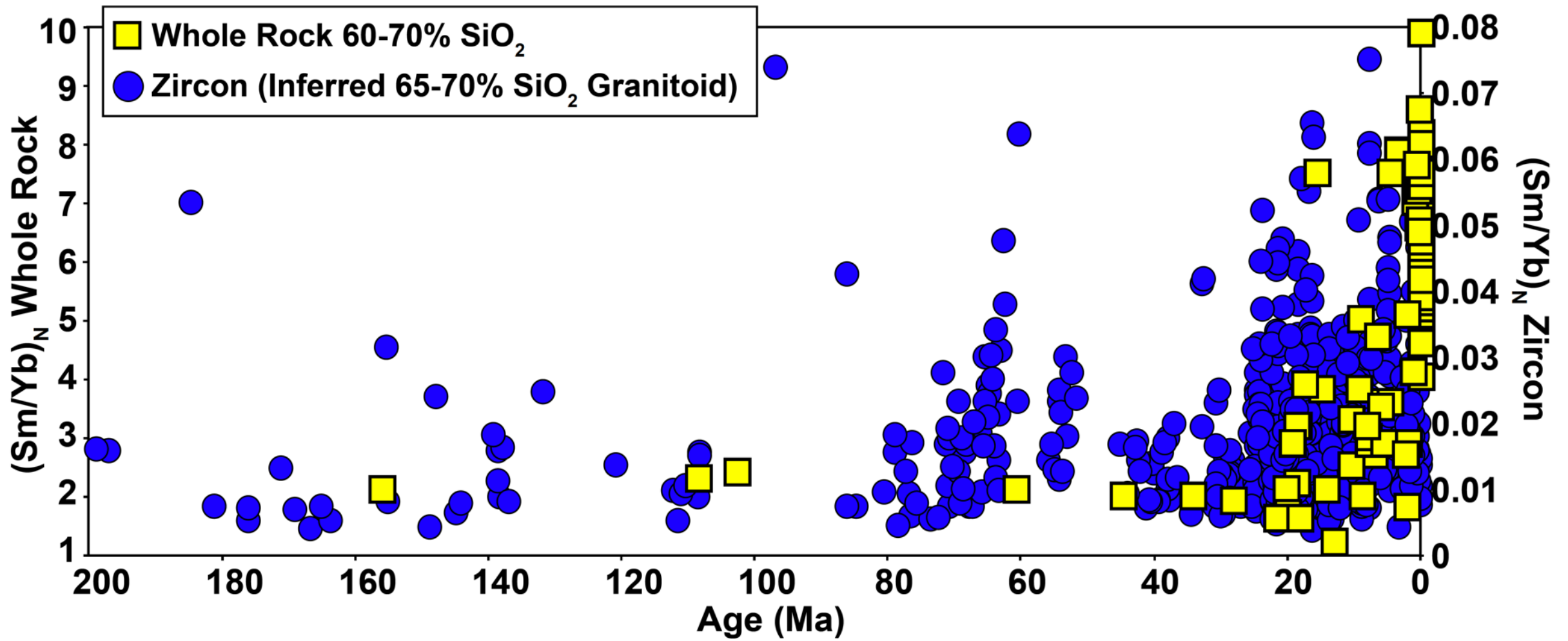
Results (Sm/Yb)_N

LREE La Ce Pr Nd **Sm** Eu Gd Tb Dy Ho Er Tm **Yb** Lu HREE

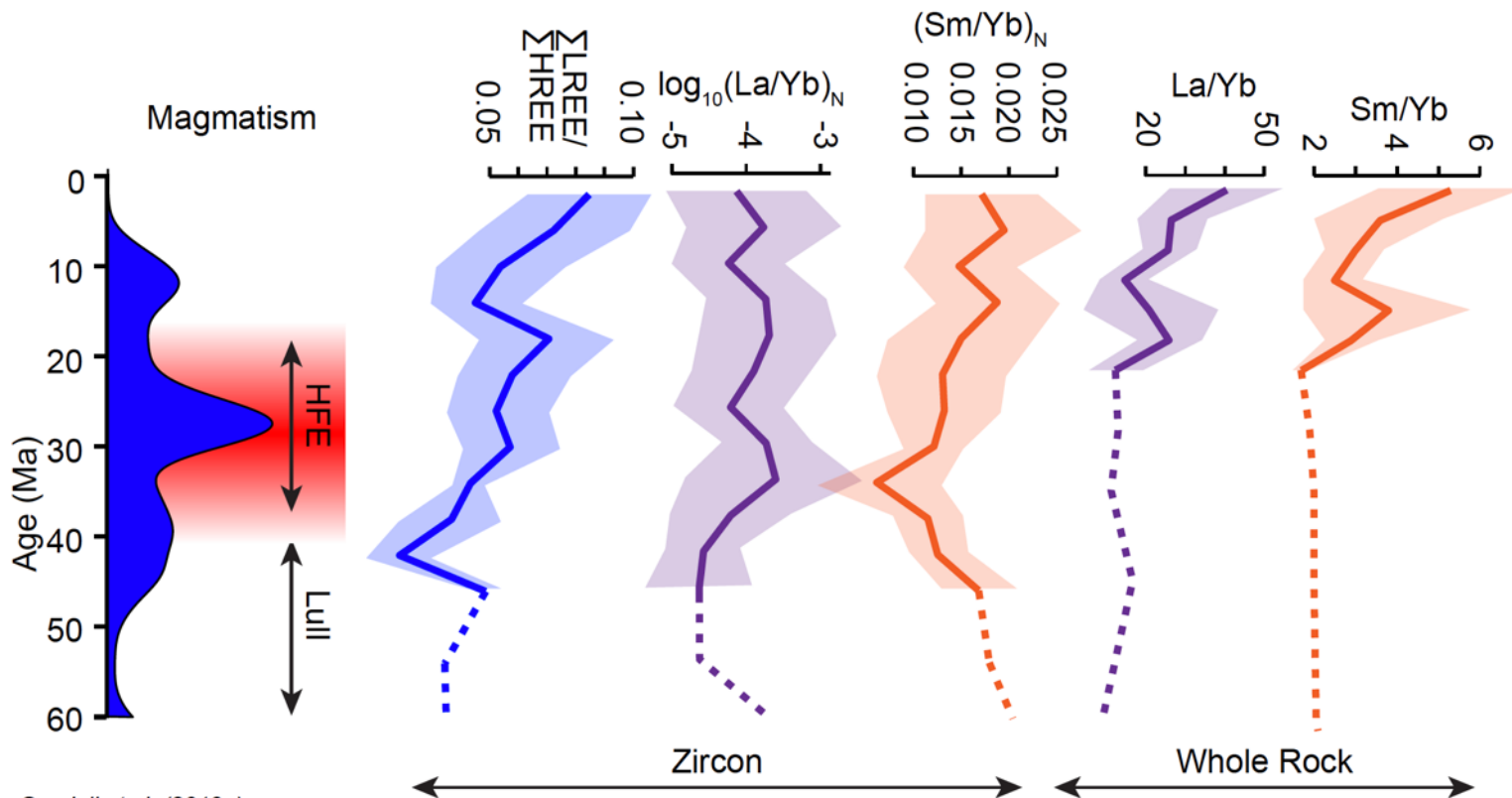


Results (Sm/Yb)_N

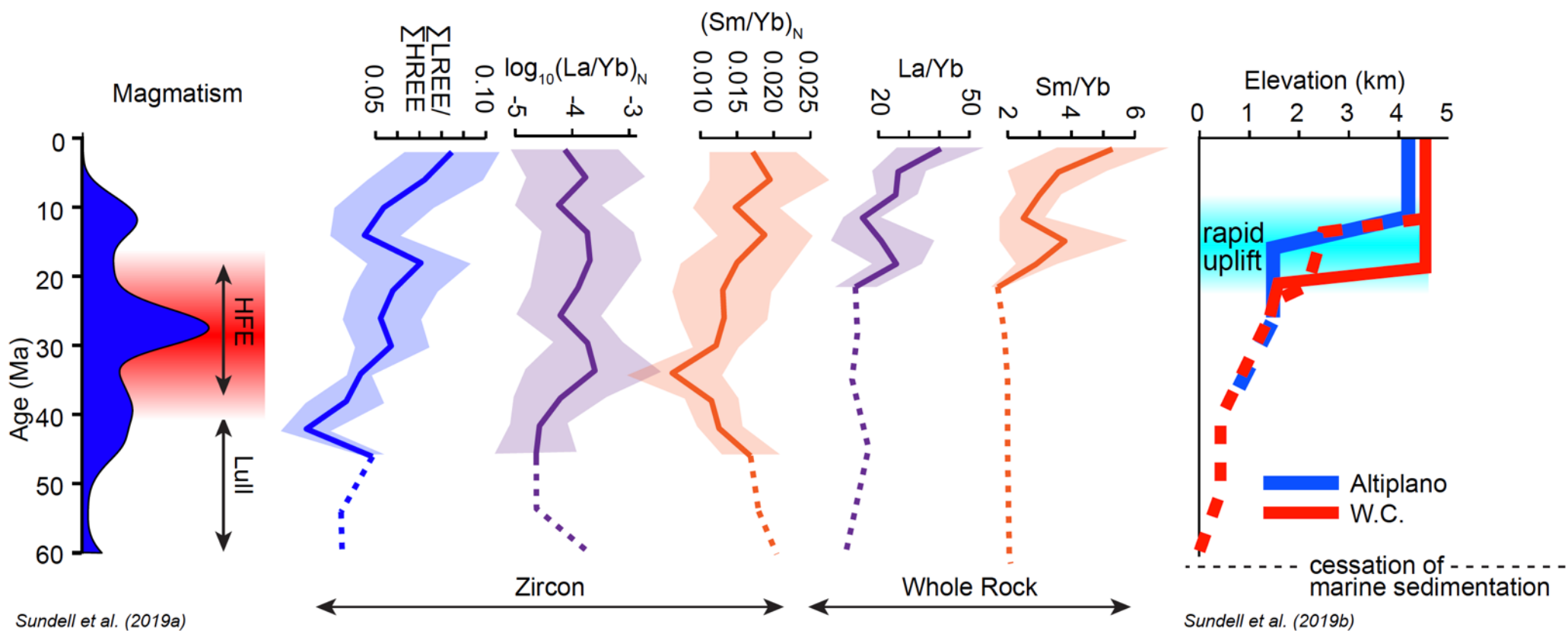
LREE La Ce Pr Nd Sm Eu Gd Tb Dy Ho Er Tm Yb Lu HREE



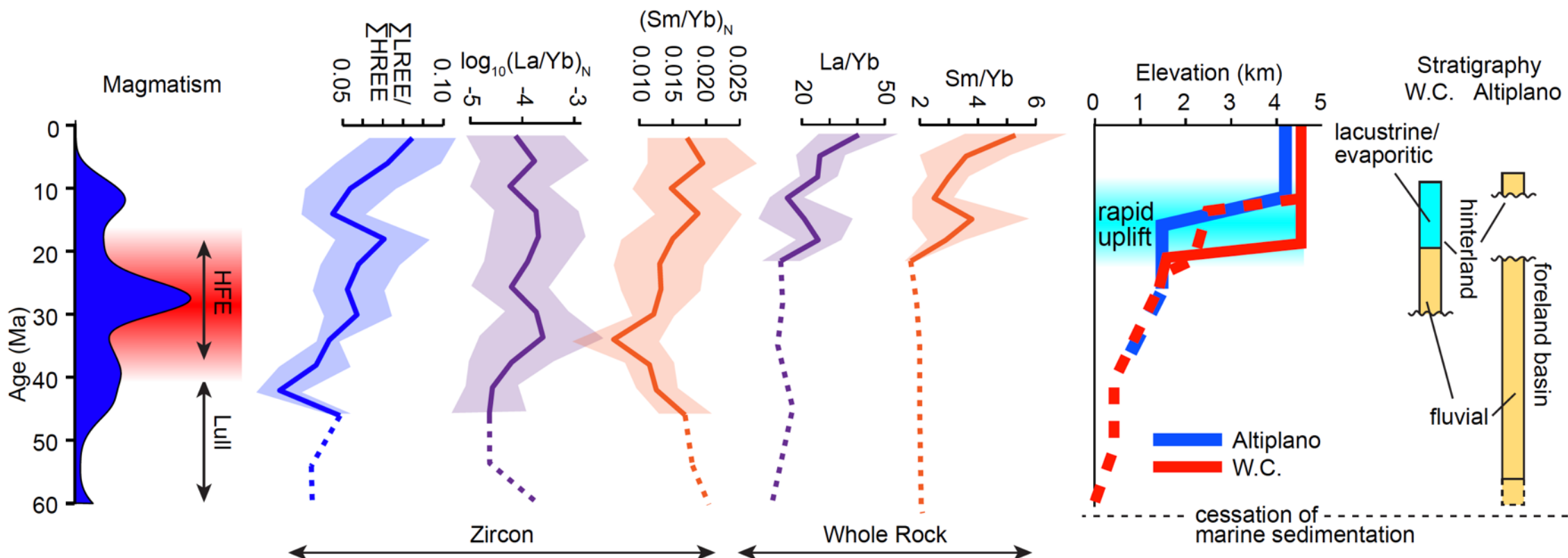
Synthesis



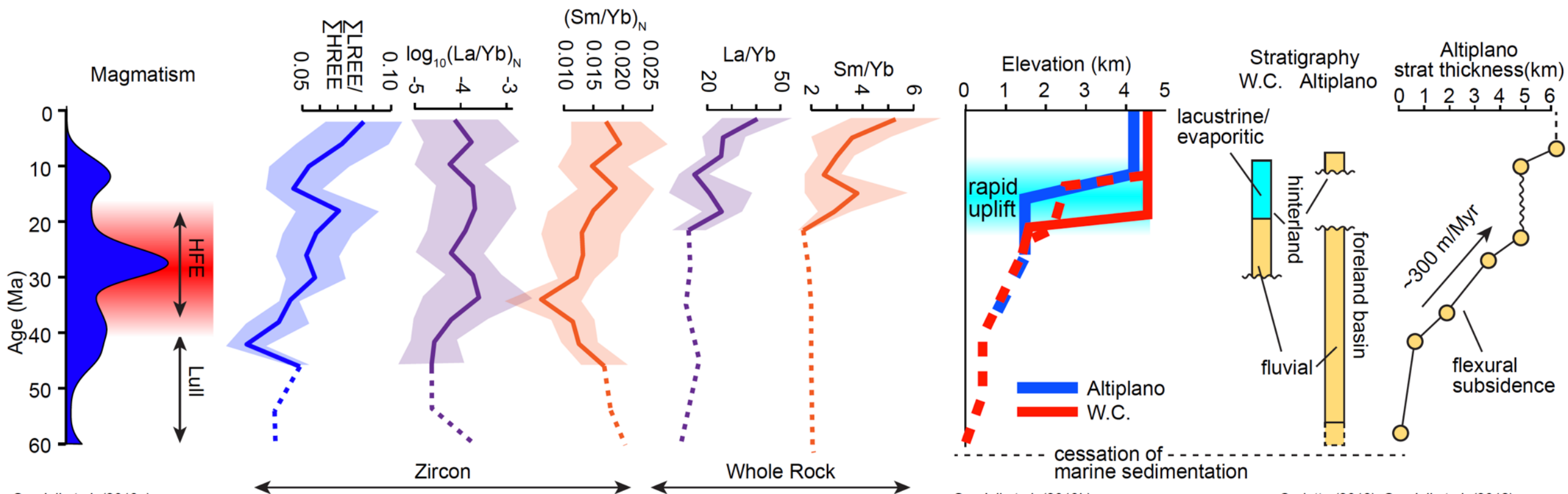
Synthesis



Synthesis



Synthesis



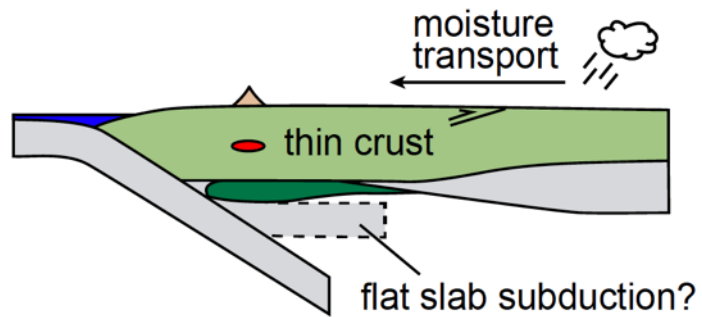
Sundell et al. (2019a)

Sundell et al. (2019b)

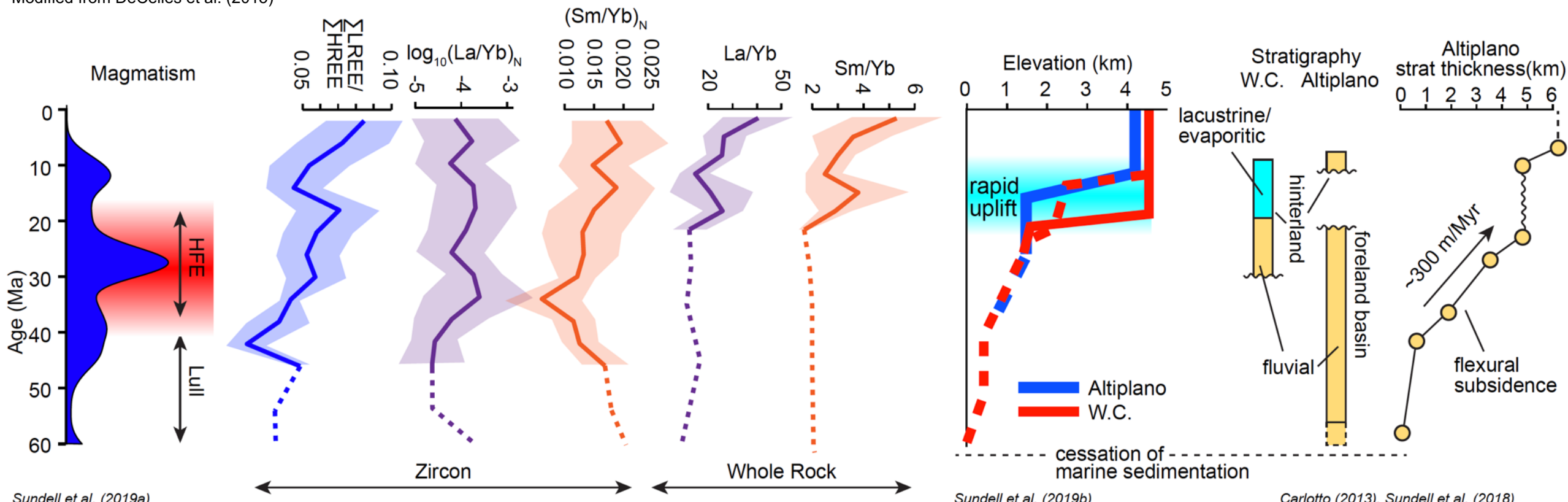
Carlotto (2013), Sundell et al. (2018)

Synthesis

60-40 Ma
Magmatic Lull

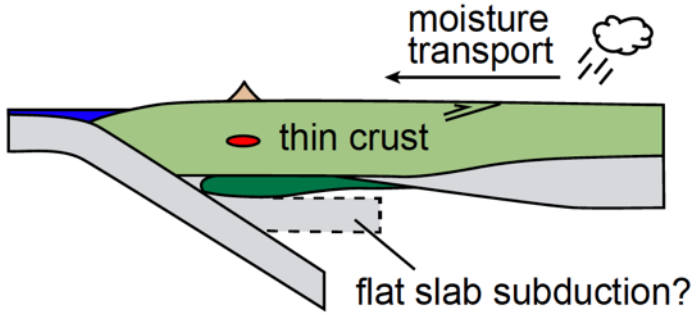


Modified from DeCelles et al. (2015)

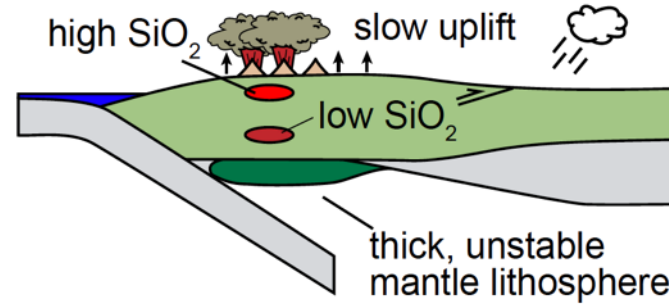


Synthesis

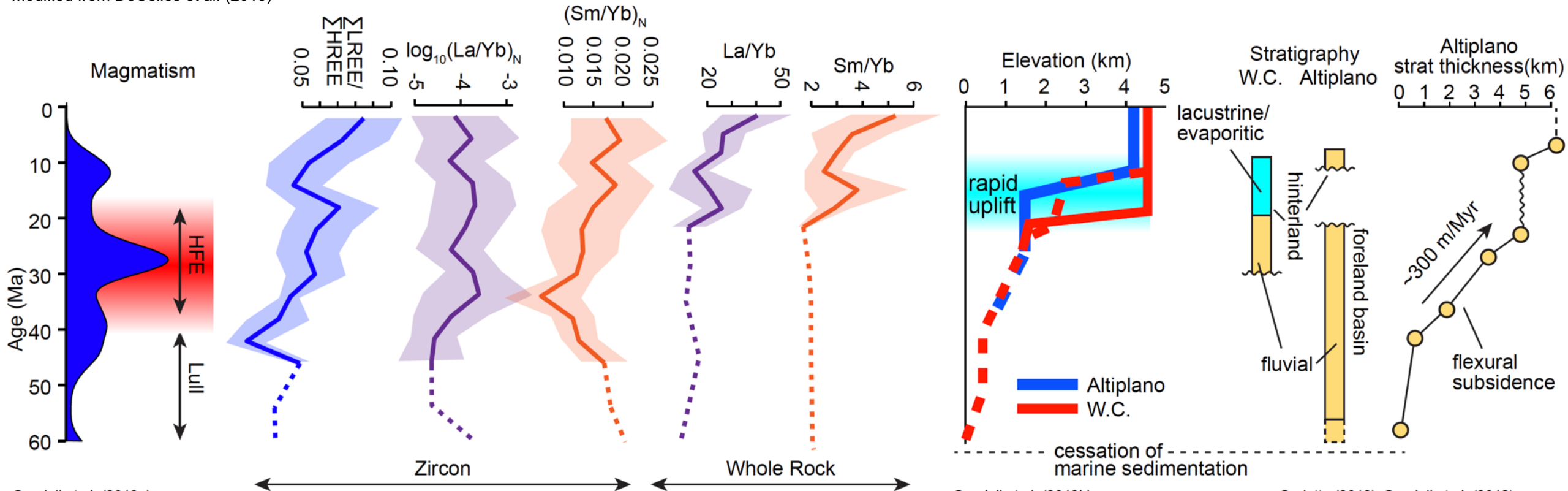
60-40 Ma
Magmatic Lull



40-20 Ma
Major crustal thickening, **HFE**

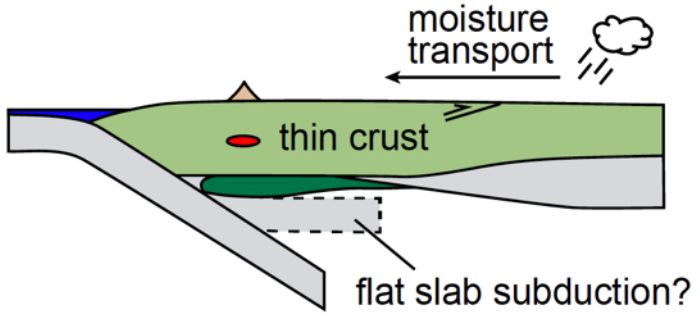


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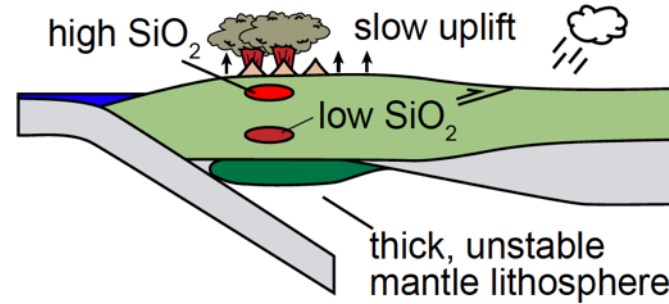


Synthesis

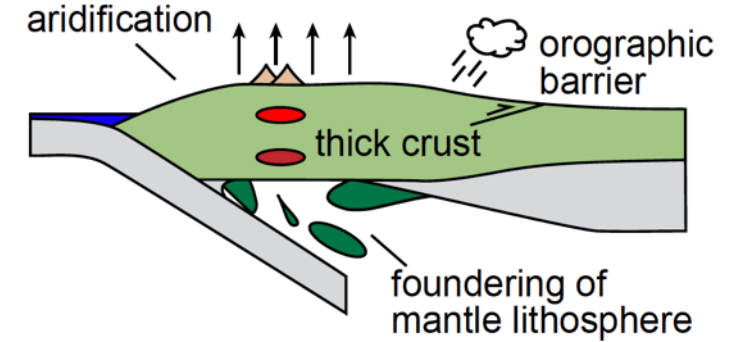
60-40 Ma
Magmatic Lull



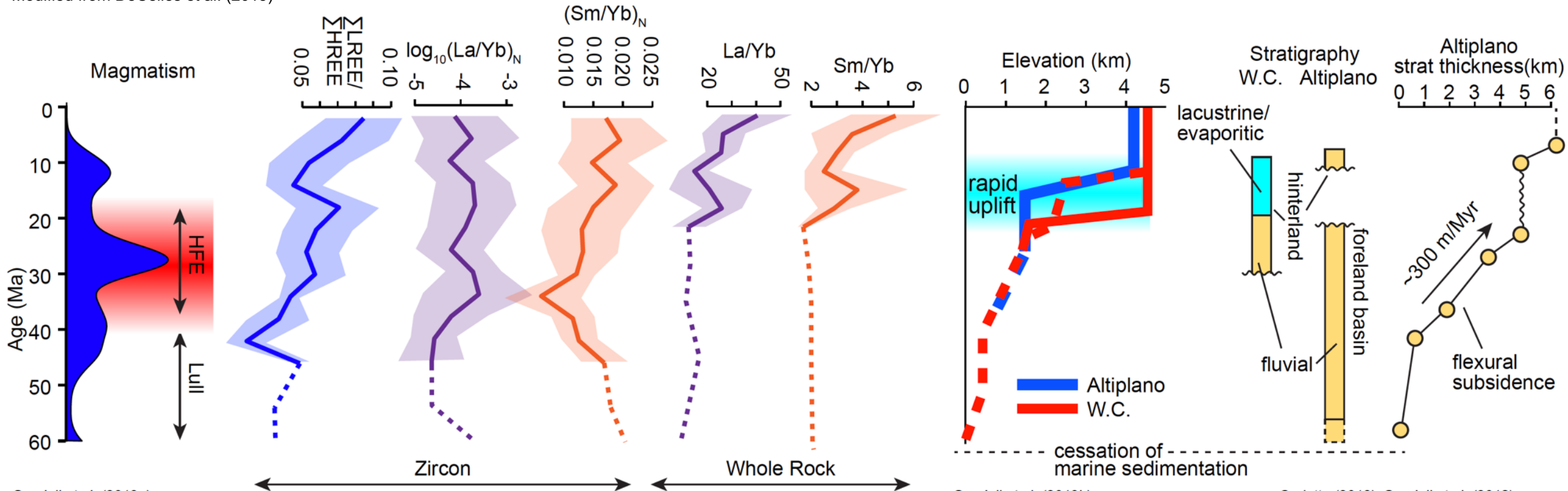
40-20 Ma
Major crustal thickening, **HFE**



20-10 Ma
Continued thickening, rapid uplift



Modified from DeCelles et al. (2015)



Conclusions

What is the timing of crustal thickening?

What is its relationship to surface uplift and paleoclimate?

Conclusions

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Major thickening 40–20 Ma, continued thickening < 20 Ma

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Conclusions

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Major thickening 40–20 Ma, continued thickening < 20 Ma

What is its relationship to surface uplift and paleoclimate?

Crustal Growth



Gravitationally unstable mantle lithosphere



Rapid surface uplift



Orography and aridification

Acknowledgements

Postdoc Advisor: George Gehrels

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UA Postdocs: Gilby Jepson, Sarah George, Allen Shaen

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**Questions
???**