

Supplementary Information

Assimilation of upper plate rocks at convergent margins contributes to the low

$\delta^{18}\text{O}$ isotopic signature of erupted magma

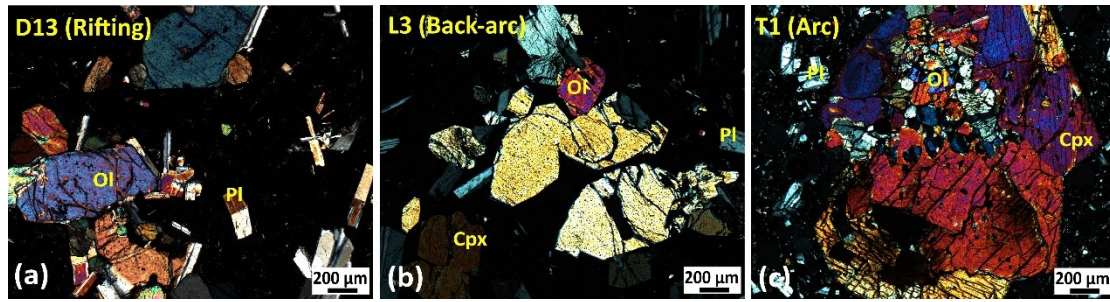
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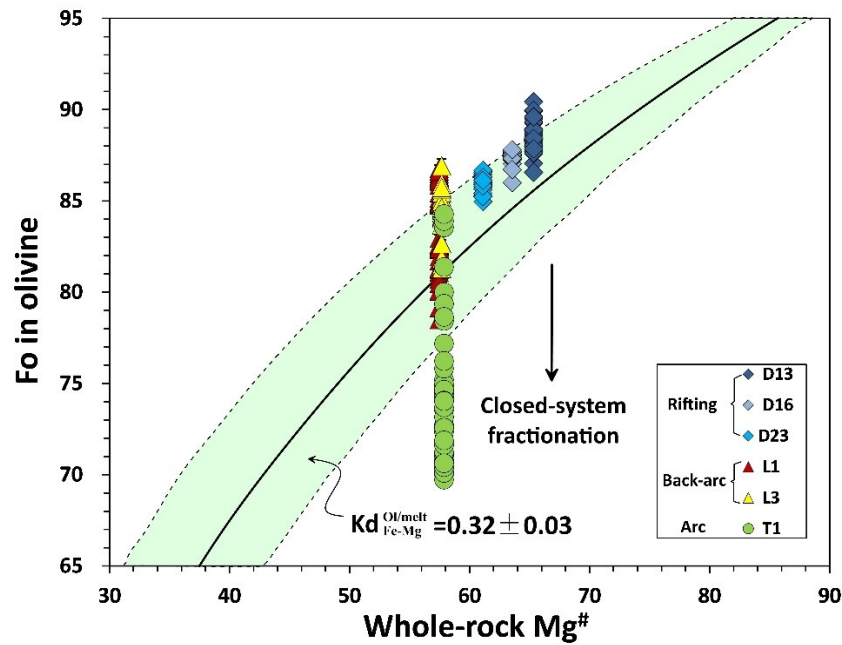
Supplementary Figs 1-4 and Data captions

Supplementary References

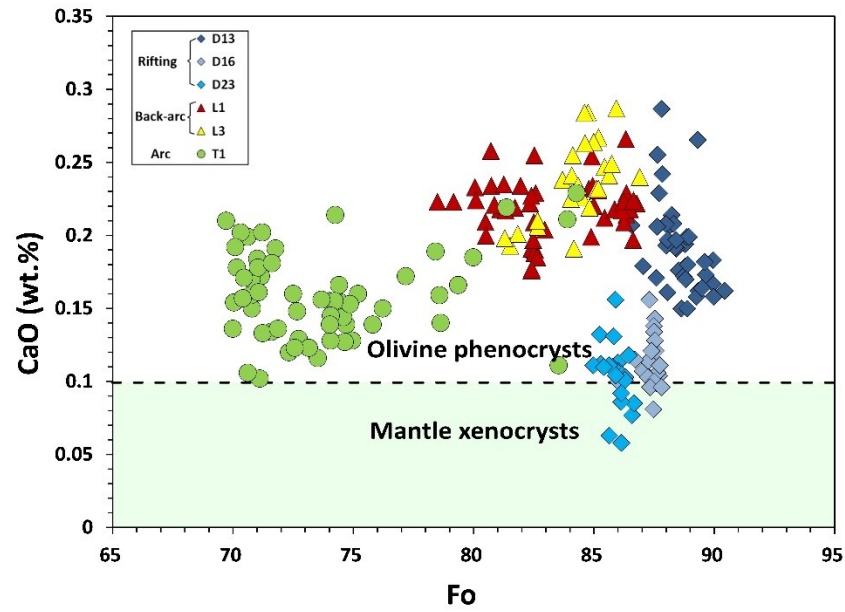
1. Supplementary Figs 1-4 and Data captions



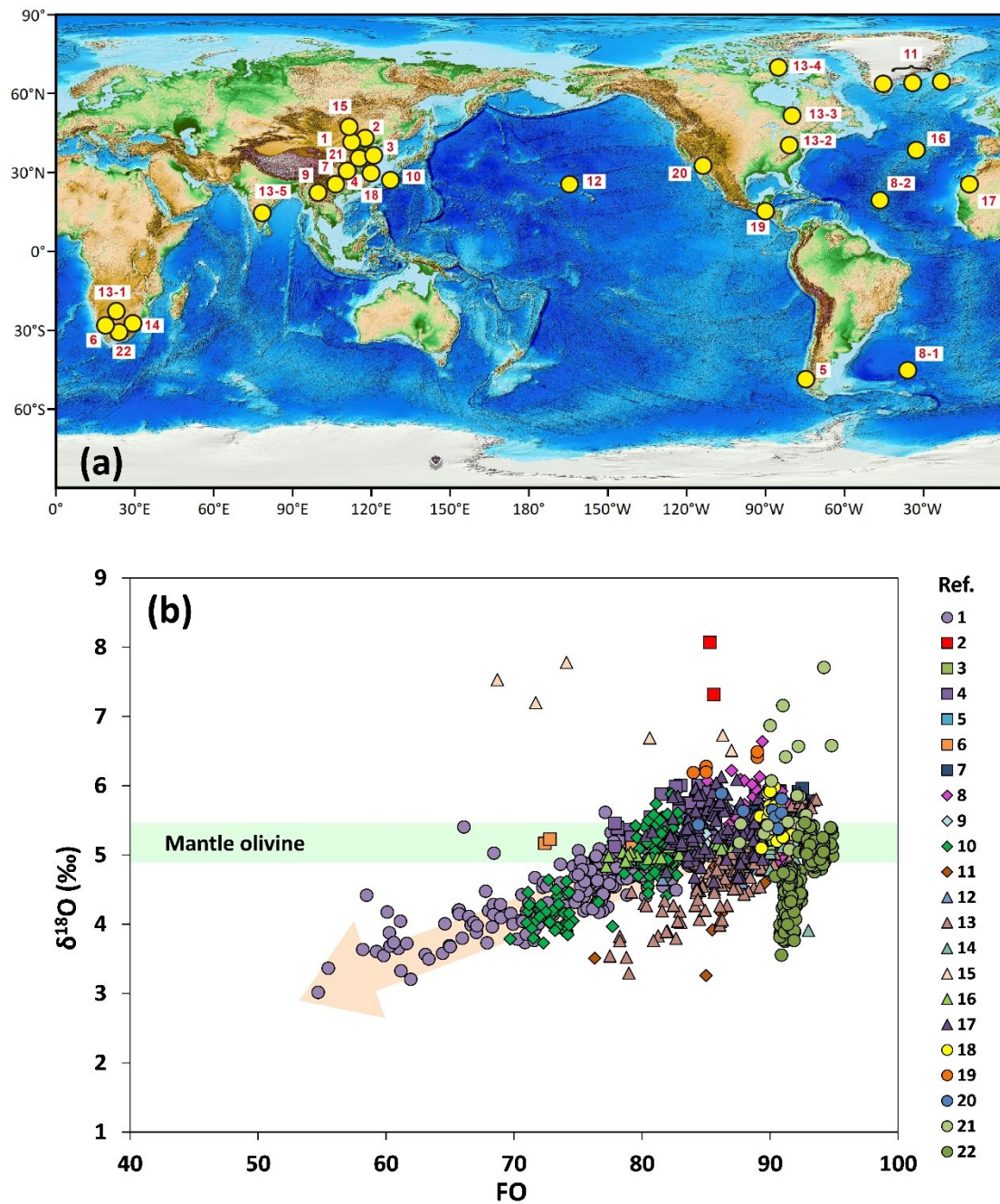
Supplementary Fig. 1. Representative photomicrographs of basalts from Mariana subduction zone. Basalt (a) is from initial rifting stage; basalt (b) is from back-arc spreading stage; basalt (c) is from active arc stage. Ol - olivine; Cpx - clinopyroxene; Pl - plagioclase.



Supplementary Fig. 2. Plot of whole-rock $Mg^\#$ values versus Fo contents of olivine compositions. The green area is the Fe-Mg equilibrium field between olivine and melt as calculated using a partition coefficient of $Kd^{Ol/melt}_{Fe-Mg} = 0.32 \pm 0.03$ ¹. Whole-rock $Mg^\#$ is cited from ref. 2. Some low-Fo olivines in Mariana arc are not equilibrated with their host whole rocks.



Supplementary Fig. 3. CaO contents versus Fo values of studied olivines from Mariana subduction zone. The dashed line that separates olivine phenocrysts from mantle xenocrysts based on CaO is from ref. 3.



Supplementary Fig. 4. A compilation of the published oxygen isotopic compositions of olivine. Yellow circles represent locations around the globe with reported oxygen isotopes of olivine (a). Published data show that almost all the evolved olivines in the world show a tendency of decreasing oxygen isotope (b). The numbers in (a) and (b) represent the corresponding references, which are listed in Supplementary Table 5.

Supplementary Data 1. Analytical major and trace elements and oxygen isotopic ratios of olivine from the Mariana subduction zone.

Supplementary Data 2. Analytical major and trace elements of different points in the same olivine from the Mariana subduction zone.

Supplementary Data 3. Major element geochemistry (EPMA) of spinels within olivine and corresponding host olivines.

Supplementary Data 4. The oxygen isotopic compositions of whole rocks from Mariana subduction zone.

Supplementary Data 5. The collected olivine data and cited references in Supplementary Fig. 4.

Supplementary Data 6. Analytical results of oxygen isotopes for standard sample of SanCarlos olivine.

Supplementary Data 7. Brief description of studied host volcanic rocks.

2. Supplementary References

1. Putirka, K., F. Ryerson, M. Perfit, and W. I. Ridley. Mineralogy and composition of the oceanic mantle. *J. Petrol.*, **52**, 279-313. (2011).
2. Li, X. et al. A HIMU-like component in Mariana Convergent Margin magma sources during initial arc rifting revealed by melt inclusions. *Nat. Commun.* **15**, 4088 (2024).
3. Thompson, R., and Gibson, S. Transient high temperatures in mantle plume heads inferred from magnesian olivines in Phanerozoic picrites. *Nature* **407**, 502–506.

(2000).