

SUPPLEMENTARY MATERIALS:

Sampling procedures: Fresh rock samples from the Northern Mariana Islands, the Central Mariana Trough and the Southern Mariana Trough (Table S1) were cleaned and cut into thin slices, which were placed into an ultrasonic cleaning machine for 15 minutes to remove sediments within the vesicles. To further minimize any possible effects of alteration, the selected samples were pretreated by cutting away their outer surfaces. No visual signs of seawater alteration were obvious during the petrographic inspection of the samples. The slices were broken into 1 to 2 mm rock chips, and all were then carefully picked manually under a binocular microscope to avoid discernable alteration. Finally, the rock chips were ultrasonically cleaned in Milli-Q water for two days with the water repeatedly changed. The rock chips were powdered (200 mesh in size) using an agate mortar for whole rock major element, trace element and isotope analyses.

Sr-Nd-Pb isotope analyses: The values of $^{86}\text{Sr}/^{88}\text{Sr} = 0.1194$ and $^{146}\text{Nd}/^{144}\text{Nd} = 0.7219$ were used for mass fractionation calibration of the measured Sr and Nd isotope ratios. The measured values were $^{87}\text{Sr}/^{86}\text{Sr} = 0.710248 \pm 0.000012$ for the NBS987 Sr standard and $^{143}\text{Nd}/^{144}\text{Nd} = 0.512117 \pm 0.000009$ for the JNdi Nd standard during the period of data collection. The mass bias of Pb isotope ratios was corrected using the measurements of the standard NBS981. BCR-2 was analyzed to check the quality of the data (Table S3). The analytical precisions of the Sr, Nd, and Pb isotope ratios were better than 0.003%, 0.003% and 0.01%, respectively. The total procedural

blanks for the Sr, Nd, and Pb isotope analyses were <200, <100, and <200 pg, respectively.

Figure S1. (a) Plots of samples in the total alkalis versus silica classification diagram ((Na₂O + K₂O) versus SiO₂). (b) K₂O versus SiO₂ (wt.%) diagram for the volcanic rocks.

Figure S2. Primitive mantle-normalized trace element distribution patterns for samples from the Mariana arc-basin system. The normalization values are from Sun and McDonough (1989).

Figure S3. Plot of Sr-Nd-Pb isotope ratios of samples from the Mariana Islands and Mariana Trough. The MORB isotopic data (red cross line) are from Zhao et al. (2016). Fields for enriched mantle I (EMI) and bulk sediment are from Zhao et al. (2016) and Freymuth et al. (2015), respectively.

Figure S4. Plots of $\delta^{98/95}\text{Mo}$ versus Mo and Th/Ce versus Th/Sm for samples from the Mariana Islands and Mariana Trough. MORB $\delta^{98/95}\text{Mo}$ and Mo values are from Bezard et al. (2016). The data for global subducting sediment (GLOSS) are from Plank and Langmuir (1998).

Table S1. Sampling locations and descriptions of the volcanic rocks from the Mariana Islands and Mariana Trough.

Table S2. Measured and reference trace element concentrations for international

standards.

Table S3. Analytical Sr-Nd-Pb-Li-Mo isotope ratios of standard samples.

Table S4. Major and trace element compositions of the volcanic rocks from the Mariana Islands and Mariana Trough.

Table S5. Mo contents and Sr-Nd-Pb-Li-Mo isotope compositions of the volcanic rocks from the Mariana Islands and Mariana Trough.

Table S6. Parameters for the mixing calculations.

REFERENCES CITED

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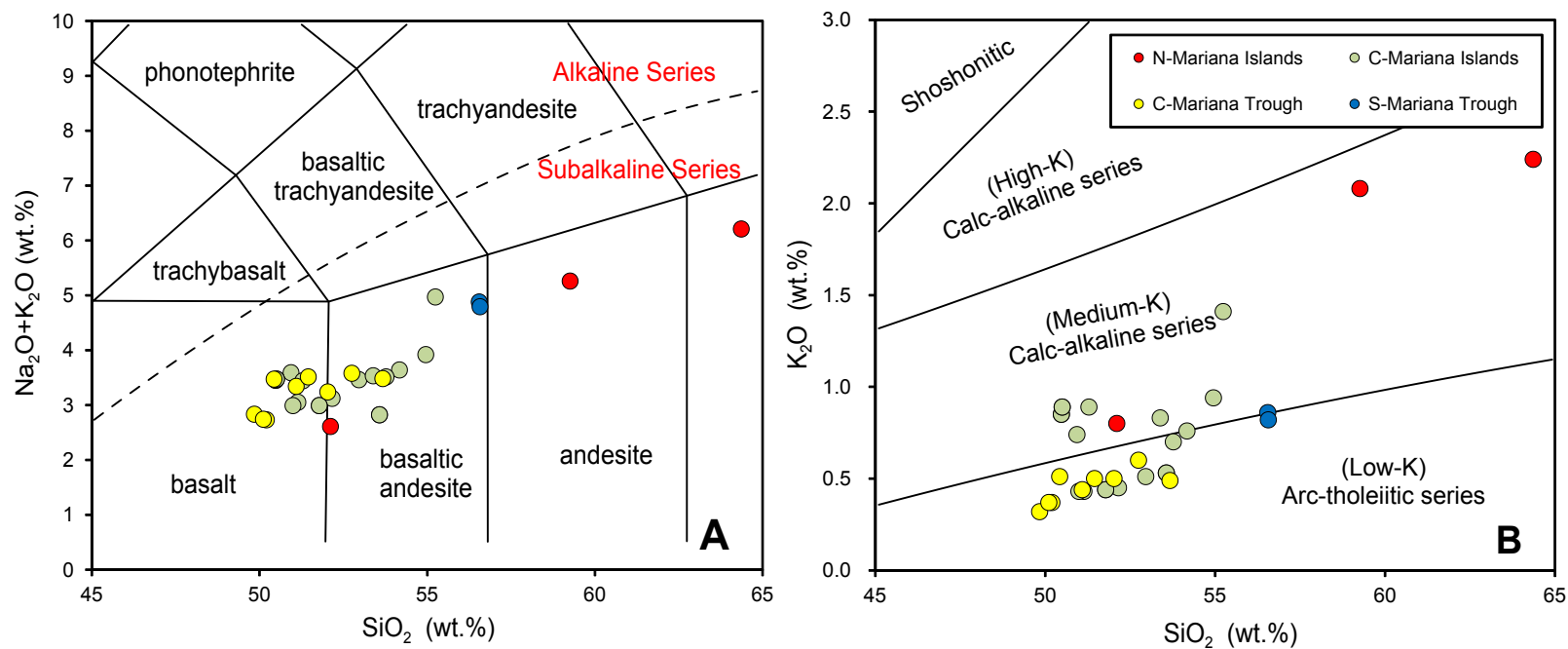


Fig. S1

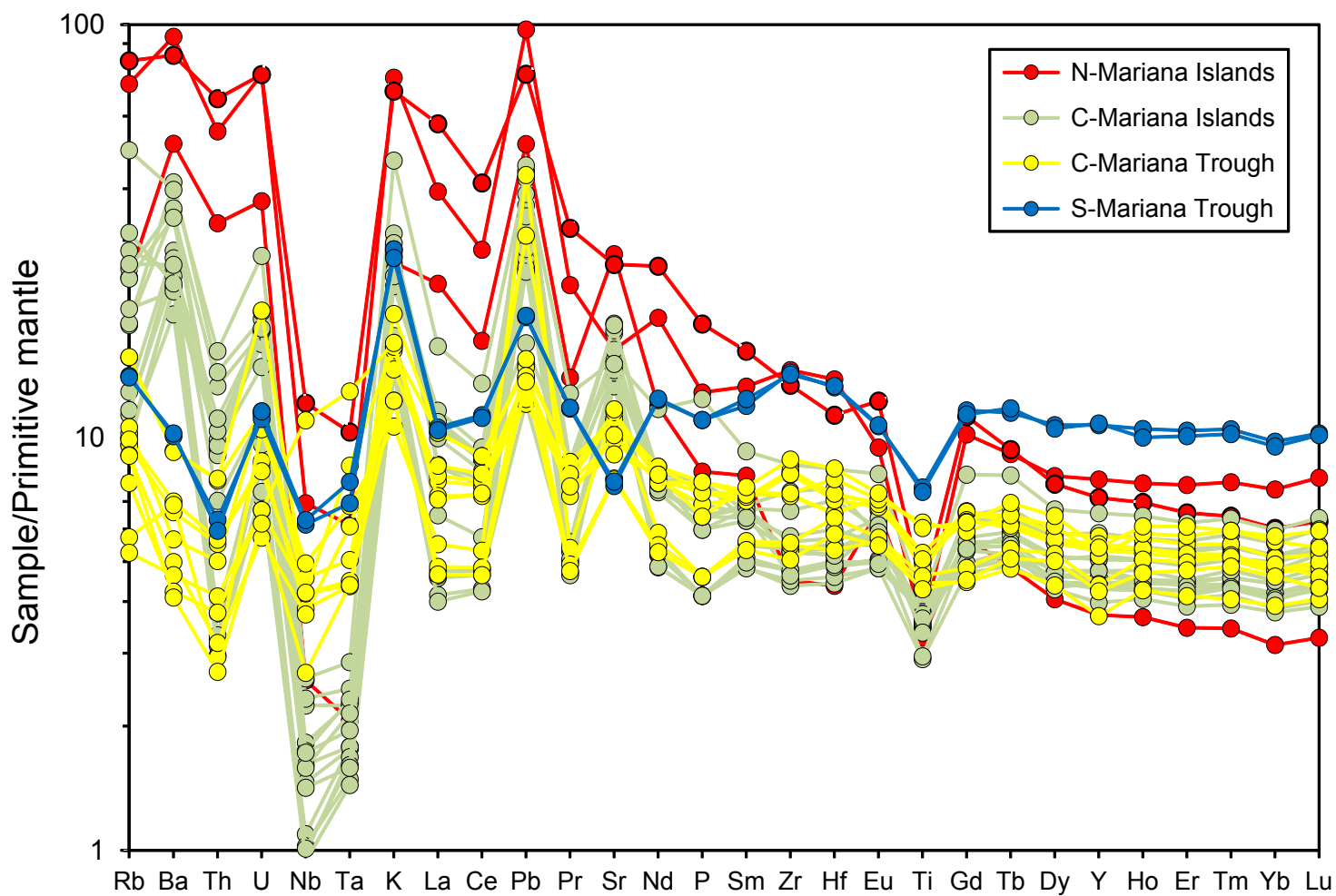


Fig. S2

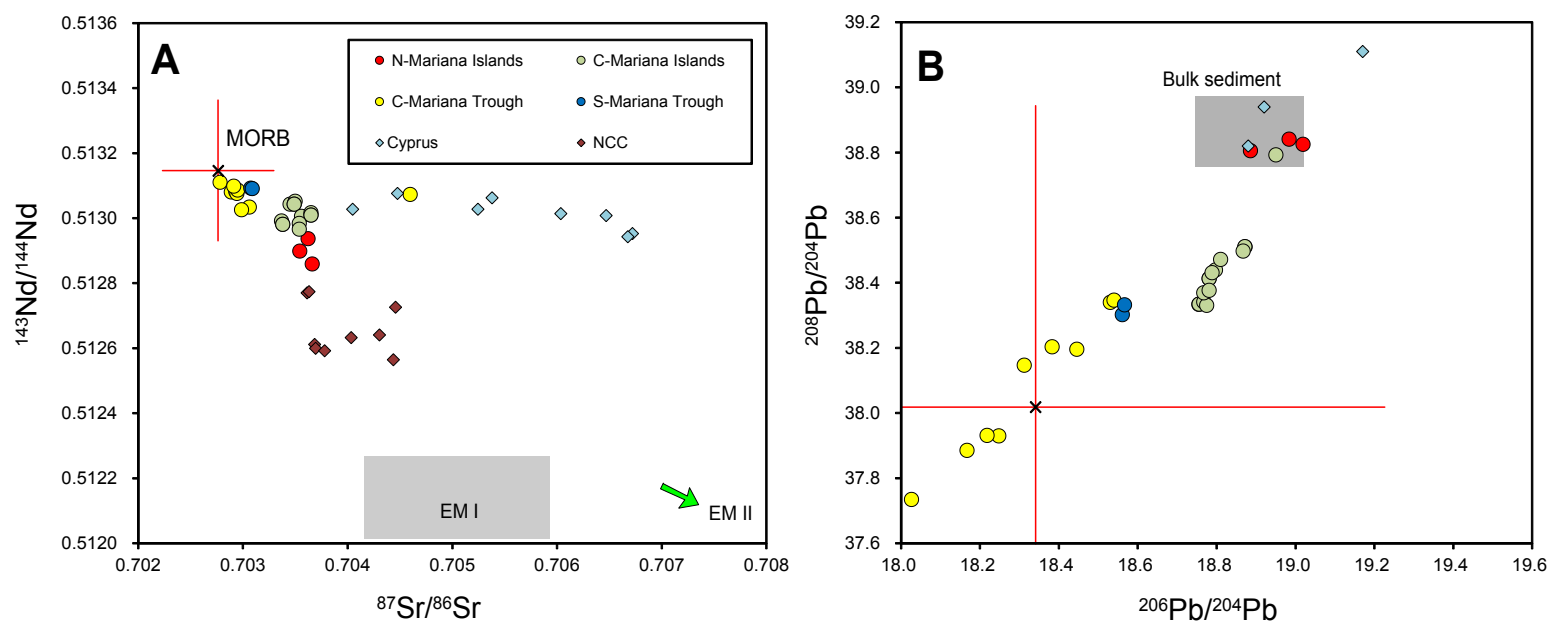


Fig. S3

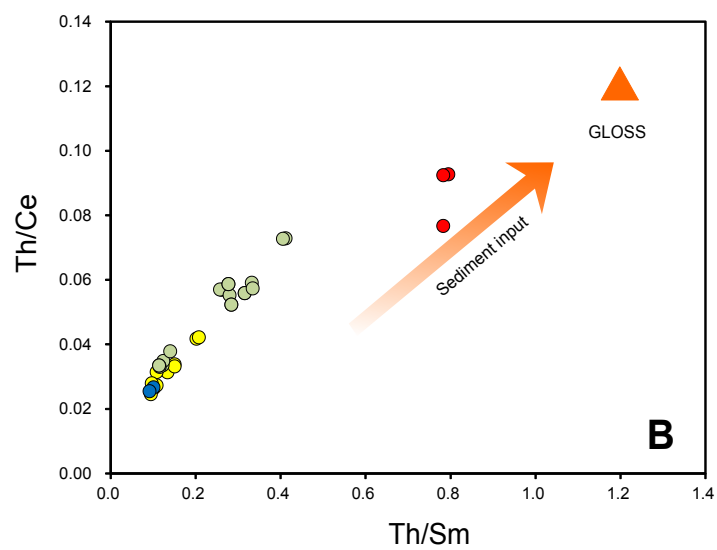
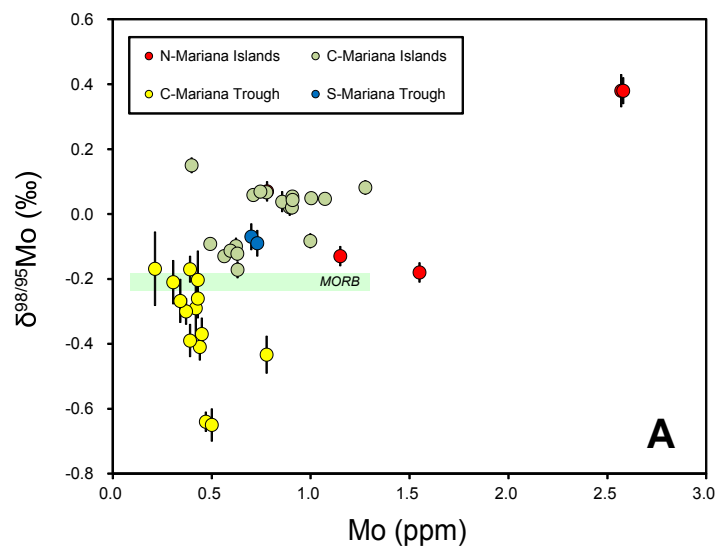


Fig. S4