SO263 – Hydrothermal vent fluids and sulphides from Maka volcano, North Eastern Lau Spreading Centre

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Introduction

This study reports on the chemical composition of hydrothermal fluids and their associated precipitates sampled from Maka volcano, situated on the North Eastern Lau Spreadig Centre (NELSC), SW Pacific (**Figure 1**).

The results yield new insight into how processes such as water-rock interaction, fluid boiling and seawater mixing are recorded by sulphide chemistry.

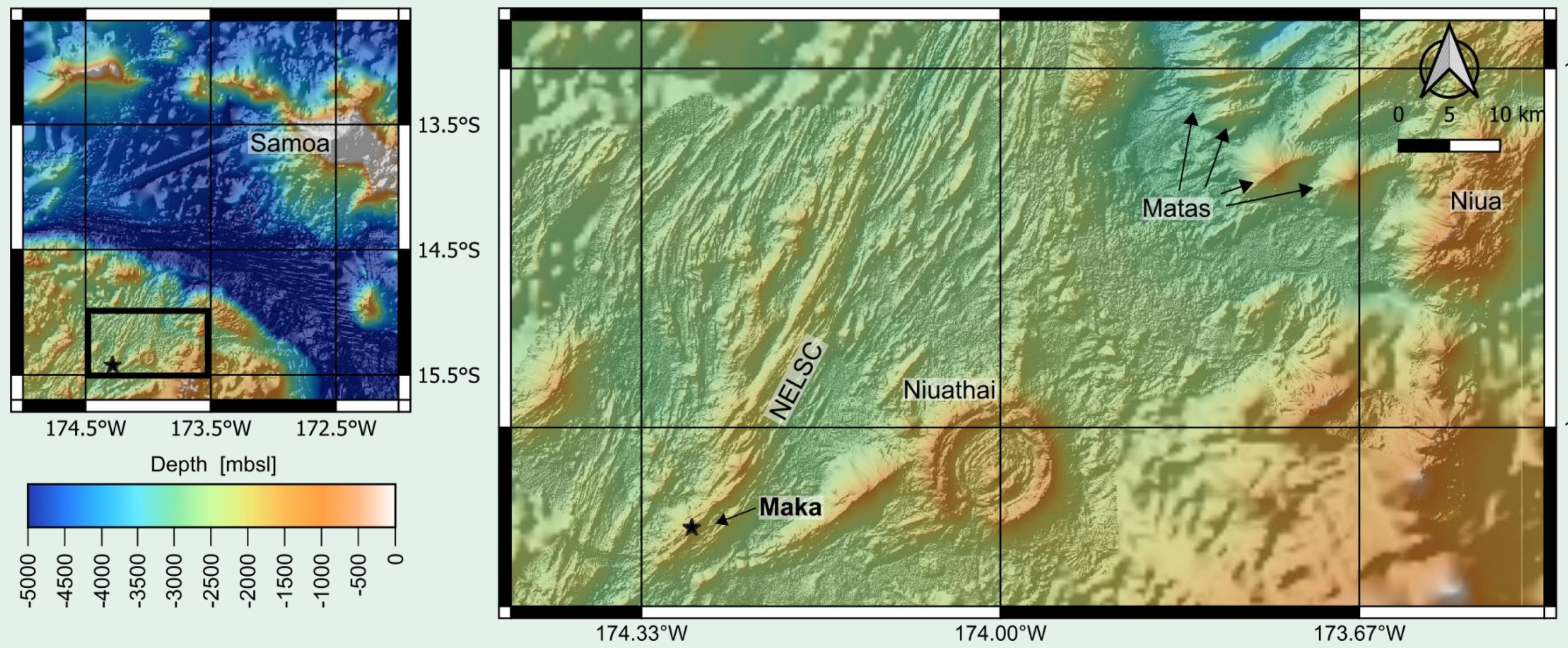

Figure 1: (A) Large scale bathymetry of the northern Lau Basin, SW Pacific Ocean. The black star marks the study site situated within the North East Lau Basin. Bathymetric data taken from (GEPCO Compilation Group, 2021). **(B)** Detailed bathymetric map of the North East Lau Basin. The sample location at Maka volcano is marked with a black star. Bathymetric data presented in (B) taken from (Merle et al., 2018)

Discussion

Fluid chemistry indicates a **three-component mixing** at Maka South including **seawater, a boiling-induced low-Cl vapour and a black smoker-type fluid** similar to that of Maka HF **(Figure 2)**.

This is also preserved by the trace element signature of hydrothermal pyrite **(Figure 3)**.

At Maka South**, high As/Co (>10 to 100) and Sb/Pb (>0.1)** in pyrite are suggested to be related to a boiling-induced element fractionation.

In contrast, **lower As/Co (<100) and a tendency to higher Co/Ni values** in pyrite from Maka HF likely reflect the black smoker-type fluid.

The **Se/Ge ratio** in pyrite provides evidence for **fluid-seawater mixing**, where lower values (<10) are the result of a seawater contribution at the seafloor or during fluid upflow.

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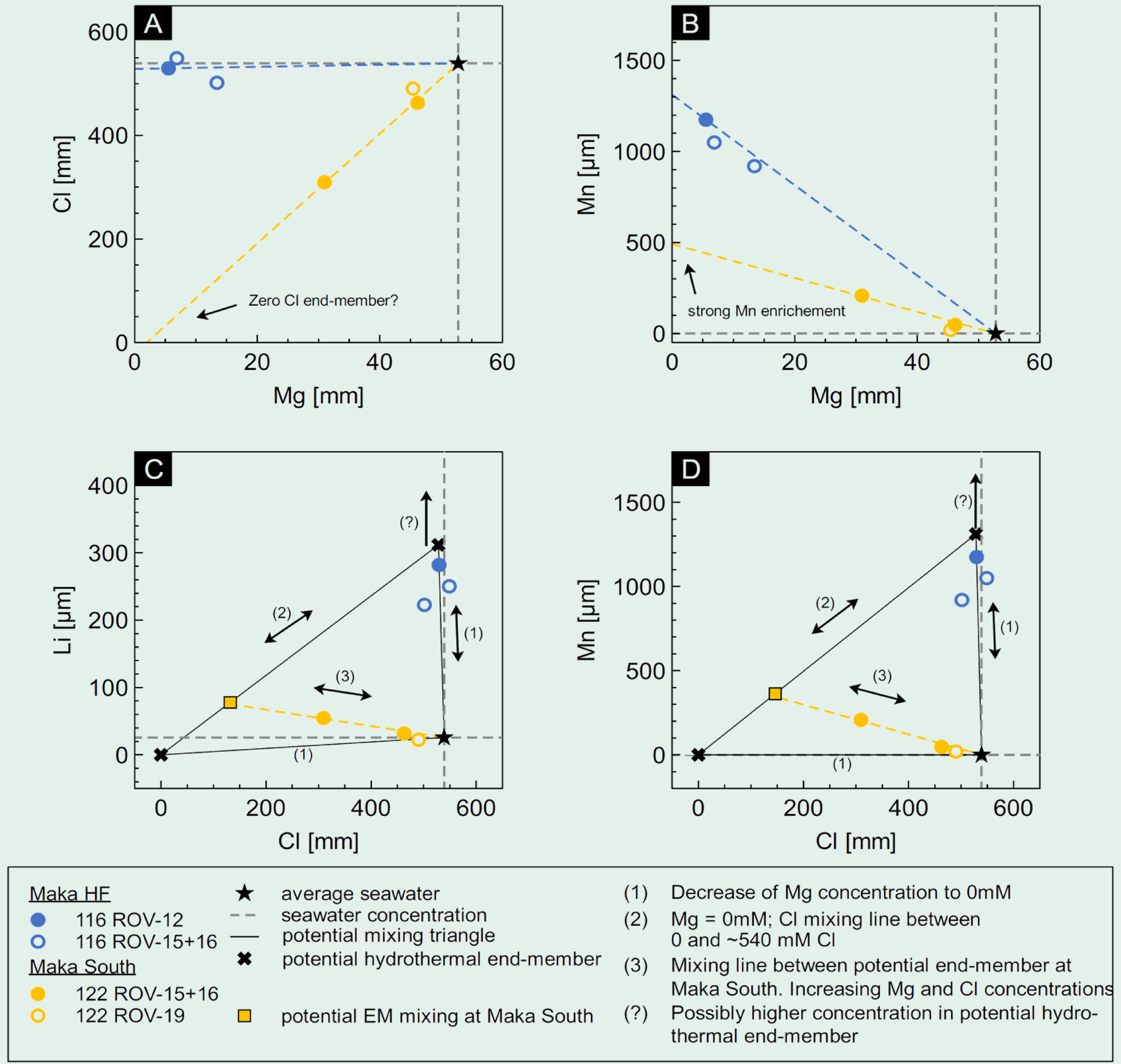

Figure 2: Bivariate diagrams of **(A)** Cl – Mg, **(B)** Mn – Mg, **(C)** Li – Cl, **(D)** Mn – Cl linear least squares regression to zero Mg indicate two different hydrothermal end-members. **(C and D)** Mixing triangle for three component mixing between **(i)** black smoker-type fluids similar to Maka HF, **(ii)** boiling-induced low-Cl vapour and **(iii)** seawater. (modified after Klose et al. 2021).

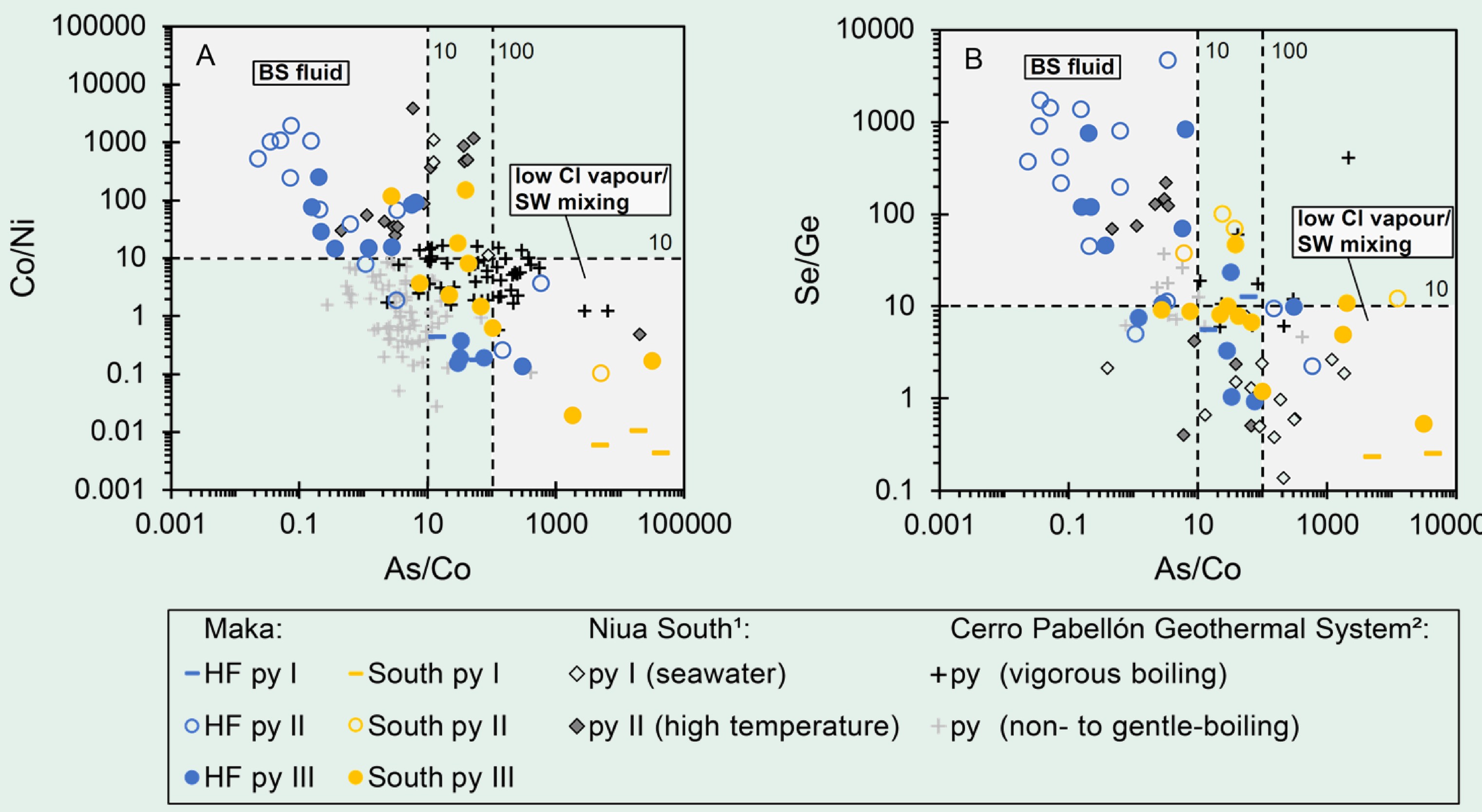

Figure 3: Trace elements ratios of **(A)** Co/Ni and **(B)** Se/Ge versus As/Co (Klose et al. 2021). Reference data from Niua South and the Cerro Pabellón Geothermal System. Superscripts: 1 = (Falkenberg et al., 2021), 2 = (Román et al., 2019).

Results

Hydrothermal Fluids: Maka HF black smoker-type fluids actively discharge at temperatures of 329 °C and are characterized by low pH values (2.8 - 3.0) and a depletion in Mg and SO_4 relative to seawater. Overall fluid composition indicative for a rock-buffered hydrothermal system at low water/rock ratios. At Maka South, venting of white smoke with temperatures up to 301°C occurs at chimneys and flanges. Also, the pH_{min} = 4.5 and Mg , SO_4, Cl, Br and Na are depleted compared to seawater, whereas metals like Li and Mn are enriched together with H_2S.

Hydrothermal Sulphides: Pyrite, chalcopyrite, sphalerite and marcasite occur throughout the chimney walls in variable proportions and exhibit distinct textures between the outer chimney wall and the central fluid conduit. The sulphide-sulphate samples from Maka HF and Maka South overlap in their bulk chemical composition. However, differences were observed with respect to the overall compositional range, as reflected by elevated Mn, Co and Bi contents at Maka HF and a tendency towards higher Cu, Zn, Se, Mo, Ag, Cd, Sb and Ba contents at Maka South. Significant variations were also observed in the trace element composition of pyrite between Maka HF and Maka South.

Conclusion

The combined use of vent fluid and sulphide chemistry provide important insights into understanding water-rock interaction, fluid boiling and seawater mixing during the formation of fossil/extinct seafloor mineralizations that formed under temporally variable fluid conditions.

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