Black Smoker Fluid Fluxes at the Niua South Seafloor Hydrothermal Vent Field, Tofua-Kermadec Arc

K.Stone[1], J.Jamieson[1], T.Barreyre[2], B. Peterkin[1]
[1]Department of Earth Sciences, Memorial University, St.John's NL
[2]Department of Earth Sciences, University of Bergen, Bergen Norway

MEMORIAL UNIVERSITY JAMIESON MARINE GEOLOGY LABORATORY

MARINE GEODYNAMICS & GEORESOURCES iMAGE

NSERC CRSNG

1.Introduction

During a 2016 expedition, the R/V Falkor visited the Niua South hydrothermal vent field located along the Tofua-Kermadec arc in the South Pacific Ocean. During this cruise, rock samples, fluid samples, and approximately 150 hours of video footage was obtained.

The aim of this study was to document all hydrothermal activity at Niua South and calculate the velocity and volumetric flux of vent fluid discharge using a specialized MATLAB coding software (PIVLab).

By combining these flux data with the fluid and geological data already compiled for this site, including vent fluid chemistry, deposit tonnage estimates, and deposit ages (using 226Ra/Ba dating), the chemical mass balance of Niua South, and the depositional efficiency of the metal mobilized by the system was determined.

2. Geological Setting

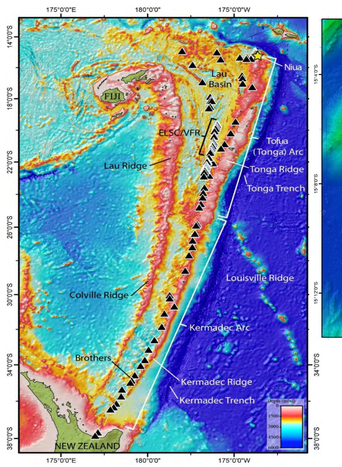


Figure 1.1 Map of the Tofua-Kermadec arc, Southwest Pacific Ocean. The yellow star to the northeast of the Lau Basin marks the location of the Niua Volcano.

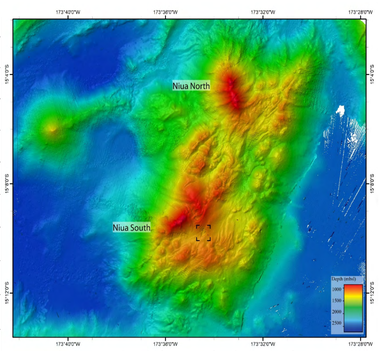


Figure 1.2 High-resolution Bathymetric map of the Niua Volcano with the location of Niua South indicated by the black box . (Peterkin et al., 2020).

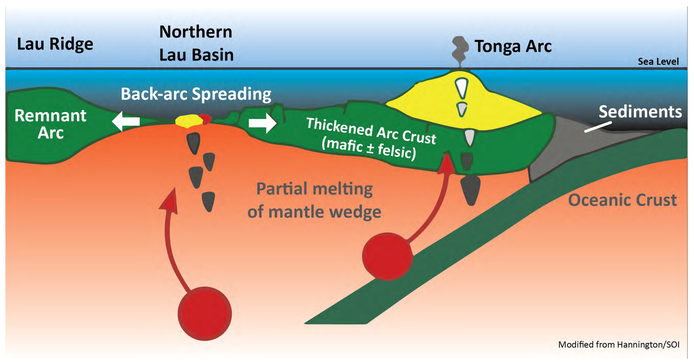
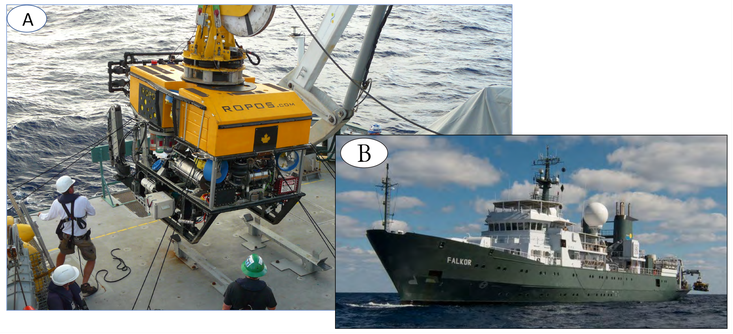


Figure 1.3 Geological cross-section for the Tofua-Kermadec arc.

3. R/V Falkor

Figure 2. A) The remotely operated vehicle (ROV) ROPOS used during the 2016 cruise, featuring the custom-built ultra-high definition (4K) camera system mounted to the ROV. B) The R/V Falkor visited Niua volcano during the 2016 expedition.



4. Research Objectives

A

Metal Flux into system = **Mass of metals retained in system** + **Mass of metals out of system**

?

- Deposit metal concentration
- Deposit Volume
- Deposit Density

- Fluid metal concentrations
- Hydrothermal Fluid Flux
- Age of deposit

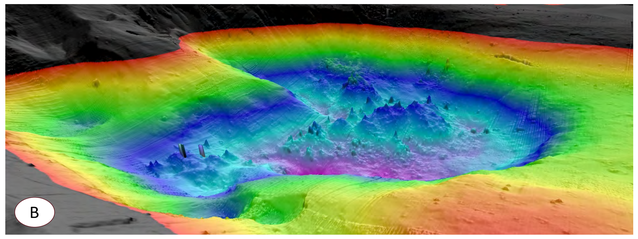
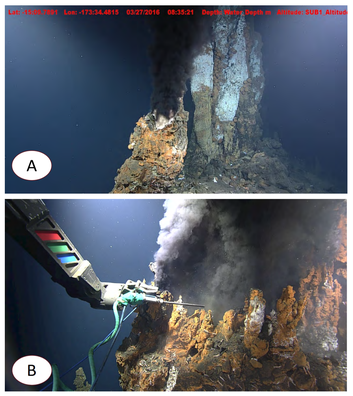


Figure 3. A) The mass balance at Niua South was calculated by considering the fluxes of metals that enter, leave, and retained within the system. B) High-resolution bathymetric map of the crater featuring hydrothermal mounds and chimneys used to determine the deposit volume. C) Hydrothermal fluid samples and temperature measurements collected during the 2016 expedition.

5. Data Collection



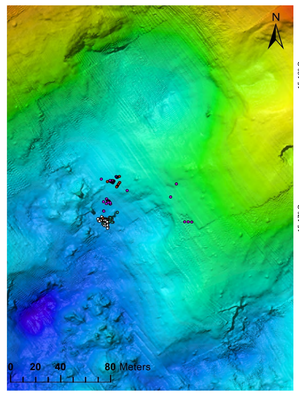


Figure 4.1 A) Hydrothermla activity documented by OFOP. B) Map showing the hydrothermal activity recorded by the OFOP software for dive 1918.

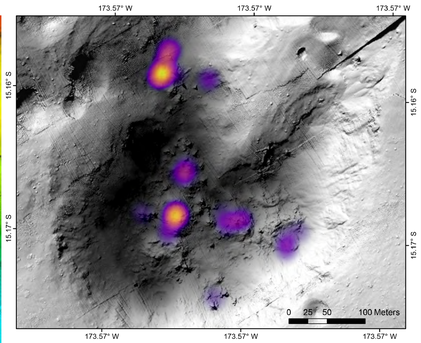


Figure 4.2 Semi-quantitative hydrothermal flux of the Niua South crater.

6. Results

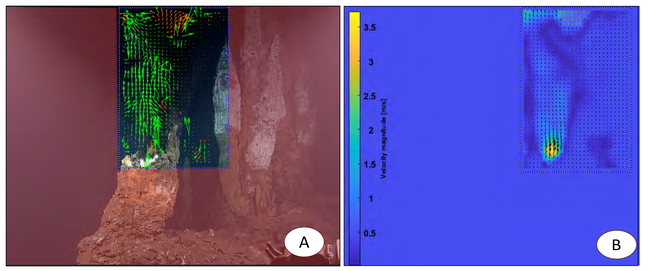


Figure 5.1 A) Analysis of flow velocity for an active hydrothermal vent through the specialized MATLAB coding software PIVLab. B) Belocity magnitude plot produced by PIVLab.

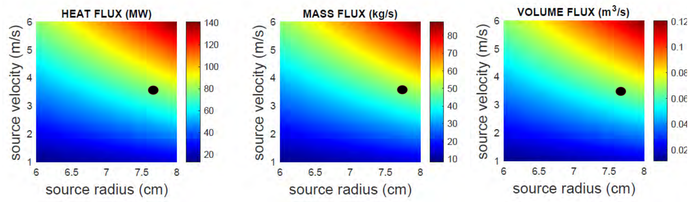


Figure 5.2 Heat flux, mass flux, and volume flux measurements for dive 1918 based on flow velocities calculated in PIVLab.

Table 1. Metal distribution and calculated depositional efficiency for the Niua South hydrothermal vent field from dive 1918 measured in tonnes.

Dive 1918	Units	Fe	Mn	Cu	Zn	Pb	Ag	Au
Mass of metals out of system	tonnes	380000	150000	8200	5900	462	6	0.50
Mass of metals retained	tonnes	27000	-	23000	6000	670	14	1.4
Mass of metals into system	tonnes	410000	-	32000	17000	1100	20	1.9
Age of the deposit	years	3000		3000	3000	3000	3000	3000
Depositional efficiency	%	7		74	35	60	69	75

7. Conclusions

- There are 24 active hydrothermal vents documented by the three sampling dives (D1918, D1919, D1920) during the 2016 cruise.

- The estimated tonnage for the Niua South hydrothermal vent field is 134,000 tonnes, which accumulated over 2900 years resulting at an accumulation rate of 50 t/yr.

- The depositional efficiencies at a single vigourously venting black smoker range from 7 to 74% for base metals and 60 to 75% for precious metals.