

Submarine magmatic-hydrothermal systems at the Monowai Volcanic Centre, Kermadec Arc

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The Monowai volcanic centre (MVC), located mid-point along the ~2530 km long Tofua-Kermadec arc system, is comprised of a large elongate caldera (7.9 x 5.7 km; 35 km²; floor depth = 1590 m), formed within an older caldera (84 km²). Associated is a large active stratovolcano, which rises to within ~ 100 m of the sea surface. Atypical of arc caldera volcanoes, mafic rocks dominate the MVC, with only rare andesites. Volcanic rocks are typical arc tholeiites, derived from partial melting of highly depleted mantle fluxed with fluids from the subducting Pacific Plate; there is little evidence for contribution from subducted sediment.

Plume mapping shows at least four hydrothermal systems with venting from the summit of Monowai cone and on its northern flank. Monowai caldera has a major hydrothermal vent system associated with the southwest wall of the caldera. The cone summit plume is gas-rich and acidic with $\Delta\text{pH} = -2.0$, $\text{H}_2\text{S} \leq 32 \mu\text{M}$ and $\text{CH}_4 \leq 900 \text{ nM}$, and total dissolvable Fe (TDFe) to 4200 nM, TDMn to 412 nM, and TDFe/TDMn (up to 20.4). By contrast, Monowai caldera plumes have lower TDFe, but range to higher TDMn concentrations, and are relatively gas-poor (no H_2S detected, $\Delta\text{pH} = -0.6$ pH units, CH_4 to 26 nM). Elevated TDMn and lower TDFe/TDMn for Monowai caldera plumes compared to Monowai cone likely reflects significant precipitation of Fe-sulfides in the subsurface, raising the distinct possibility for the occurrence of buried massive sulfide mineralization at Monowai.

Particulate samples are enriched in Al, Ti, Ca, Mg, Si, and S, with the cone summit plume particularly enriched in K, As, W and Cu, Pb, Zn. The elevated Ti and Al suggest acidic water-rock reactions and intense high-sulfidation alteration of the host volcanic rocks. Monowai caldera has numerous vents (< 60°C) and a large biomass of vent-associated fauna, including the mussel *Bathymodiolus sp.* and the tubeworm *Lamellibrachia sp.*

Monowai cone shows evidence of significant magmatic volatile $\pm$ metal contributions to its hydrothermal system. By contrast, Monowai caldera is dominated by hydrothermal water-rock reactions.

Sequential leaching methods for strontium isotope stratigraphy: Analysis of marine authigenic carbonates and phosphates

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Strontium isotope stratigraphy (SIS) involves the correlation of geographically separated strata using their Sr isotope signatures. The use of SIS is based on evidence that seawater is generally homogeneous with regard to its Sr isotope composition - this is because the residence time of Sr in the ocean (~2 Ma) is >1000 times longer than its ocean circulation time (~1500 a) - and assumes that marine authigenic sedimentary components preserve the original Sr isotopic ratio of ancient seawater. Marine Sr isotope data derive mainly from calcitic and apatitic fossils, and more rarely limestones, which together have been used to reconstruct secular trends in seawater $^{87}\text{Sr}/^{86}\text{Sr}$ (eg. [1]). However, the extent to which other marine authigenic minerals may provide primary information about ocean composition has been less well studied, and inappropriate leaching methods often applied. Bailey *et al.* [2] revealed that Sr from non-target phases may substantially contaminate the $^{87}\text{Sr}/^{86}\text{Sr}$ of a limestone sample and must be avoided when analysing bulk limestones for SIS. Here we widen the scope of those experiments to dolostone and phosphorite as well as limestone samples. The samples were collected from the Xiaotan section on China's Yangtze Platform which spans the late Neoproterozoic to basal Cambrian. These samples contain micrite, francolite (phosphate) and dolomite. Micrites and dolostones were leached using 0.3% acetic acid to dissolve 30% and 40% of the carbonate fraction, respectively. Phosphorites were first leached by 0.3% acetic acid to dissolve all the carbonate fraction and then attacked using 0.05M nitric acid to dissolve the phosphate phase. The Sr released after each leaching step was analysed isotopically using TIMS at Royal Holloway, University of London.

Our data show that the second leachate yielded significantly lower $^{87}\text{Sr}/^{86}\text{Sr}$ ratios than the first leachate by up to 0.0006 in 15 out of 19 micrite and by up to 0.0037 in 9 out of 11 dolostone samples (only two second leachates had significantly higher values by up to 0.0011). The phosphate phase yielded similar $^{87}\text{Sr}/^{86}\text{Sr}$ ratio as the carbonate leachate of the same sample (within ± 0.0002 in all 5 phosphorite samples) and these ratios fell in the stratigraphic trend.

Based on our and previous studies, we give out a simple guideline for future use of authigenic sediments for SIS.

[1] Veizer *et al.* (1999) *Chem. Geol.* **161**, 59– 88. [2] Bailey *et al.* (2000) *Chem. Geol.* **167**, 313–319.