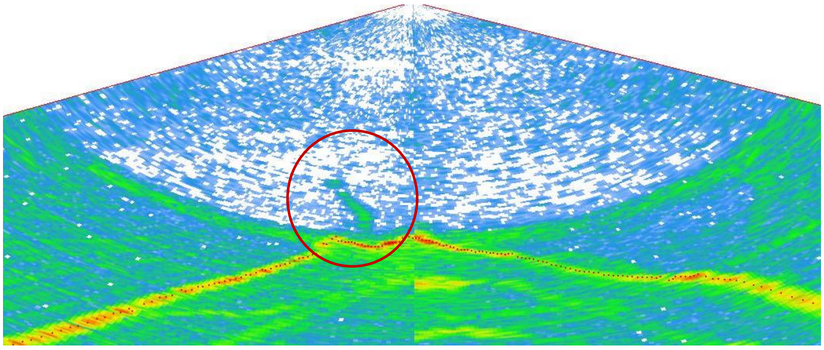
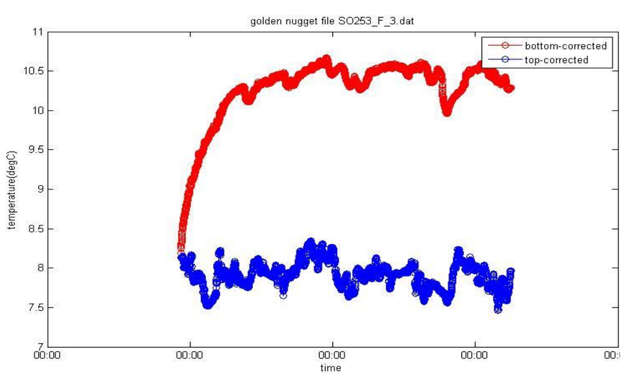
SO253 3. Weekly Report 02.– 09.01.2017

The majority of this week was spent at Haungaroa volcano, our second working area where in contrast to Macauley no dives had been done previously. Evidence for hydrothermal venting were from CTD tows 14 done years previously. The area was first mapped by high-resolution multibeam, including both the seafloor and the lower water column, which discovered a significant gas plume (see figure). We started the first ROV dive in the morning of 1 January, targeting a plateau area on the crater rim at 670 m water depth, where the largest plume signal had been recorded. We were lucky to arrive at an actively venting area soon after landing on the seafloor. We used this and the next dive to explore the newly discovered vent field with its spectacular lava structures, abundant fauna and both diffuse and focussed venting. We collected rock, chimney, fluid and mussel samples from various places. The volcanic facies is dominated by pillow and autobrecciated blocky lava as well as layers of coarse tephra. Small sulfide-barite chimneys, about 50-70 cm in height, were discovered at Haungaroa. Older, inactive sulfide chimneys nearby were densely covered by barnacles.



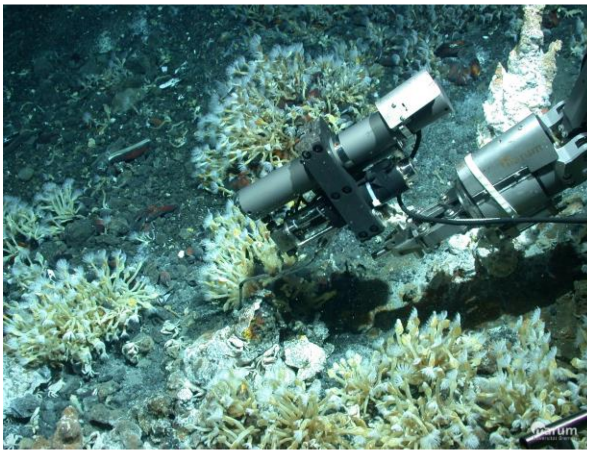
Haungaroa, NW caldera rim: gas flare at the volcano top rising into the water column; data from EM122 visualized with Fledermaus Midwater

Four thermal blankets were deployed during the ROV Quest dives at Haungaroa. The blankets showed a significant heat-flow anomaly at this site located on the caldera rim. These preliminary results show that the temperature of the seafloor is on average 3°C warmer than the surrounding seawater, implying heat-flow values of the order of ~50 W/m^2.



Deployment of heat blanket at Haungaroa. The blue profile is the seawater temperature, whereas the red profile represents the heat coming up through the seafloor.

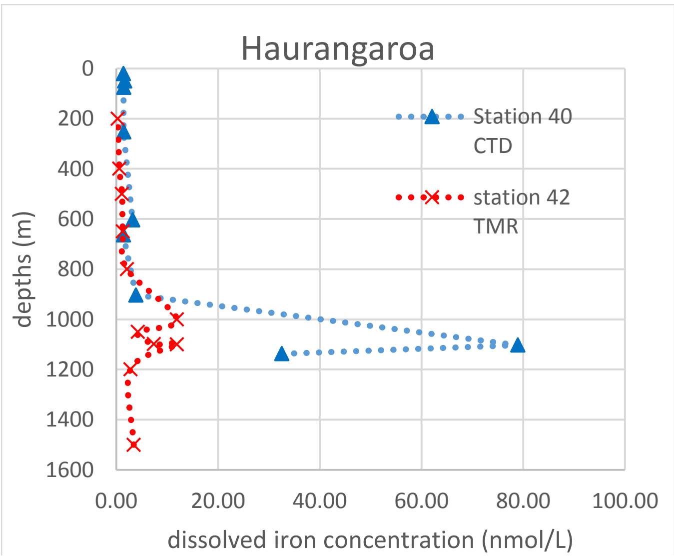
While the fluid chemistry at Macauley was characterized by sulphuric acid solutions with pH around 1 and very high Fe, Si, and Mg concentrations, the Haungaroa fluids are of a completely different composition and represent a system dominated by carbonic acid fluids. Sampling of hydrothermal vents in the summit area of Haungaroa, between 680 and 690 m water depth, yielded actively venting fluids with temperatures between 210 and 267°C. The hottest fluids



Sampling of the 267°C hot boiling fluid with a gastight IGT sampler at Haungaroa

were actually boiling, as indicated by the appearance of vapor bubbles at the vent orifice, which collapsed immediately in the rising plume due to condensation under decreasing temperatures. The associated chimneys had minor chalcopyrite lining their conduits, which is rarely seen in vents from these relatively shallow depths. Unlike the system at Macauley Cone, the fluids had higher a pH of around 4, but were still very gassy. Besides high CO_2, the fluids had noticeable amounts of H_2 and CH_4,.and are rich in dissolved sulfide, although concentrations were not quite as high as at the Macauley Caldera. Also metal concentrations are significantly lower but Si concentrations higher at Haungaroa than at Macauley. We hope that we can use the depth dependency of the quartz solubility to estimate the endmember temperature of the vent fluids more precisely.

We also sampled and prepared water samples for the quantification of dissolved manganese(III), which is an intermediate species between dissolved Mn(II) and the solid state of Mn(IV). The presence of Mn(III) in hydrothermal plumes allows any bacteria present to reduce and oxidize compounds more easily, and may have an influence on important element cycles in the deep sea, such as carbon, nitrogen and iron. Other subsamples for additional studies, previously mentioned in the 2nd report were taken at Haungaroa as well.

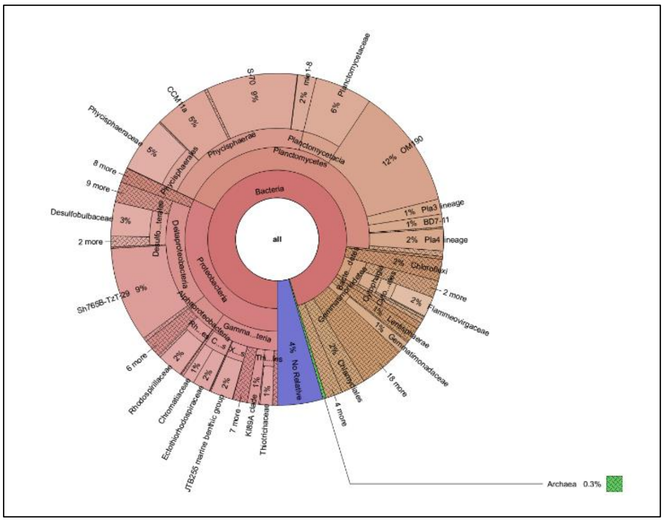


Vertical dissolved iron profiles measured with the FIA in samples from a CTD and a Trace Metal Rosette (TMR) station at different distances to the vent source

A trace metal rosette was deployed at Haungaroa volcano, north-east of the caldera outside the area where in-situ sensors were able to detect the typical redox and/or turbidity anomalies associated with hydro-thermal plumes. While we were still able to detect dissolved iron at the plume height of 11 nano moles per litre, we were likewise able to measure 0.28 nano moles per litre of dissolved iron above the plume, demonstrating contamination-free sampling. All CTD samples and samples taken by the ROV that were too low in iron concentrations to be analysed by the colorimetric method were also analysed on board ship by the FIA system, which allows us to see almost in real time the distribution of iron in the plume down to background concentrations.

Radium isotopes in plume fluids at Haungaroa are lower in radioactivity than at Macauley, although the endmember ratio of the two short-lived isotopes is very similiar. Plume ages at Haungaroa are a factor of 5 higher than at Macauley indicating a longer residence time of vent fluids in this area, most possibly because the fluid flow from the volcano is lower.

Subsamples of plume, fluid, and rock samples were also taken in order to analyse community structures and the function of free-living microorganisms. Onboard, 16S rRNA tag sequencing and analysis was done and showed first insights into the microbial diversity present at Haungaroa.



Krona chart showing the microbial diversity in a sediment sample obtained from Haungaroa.

The chemosynthetic fauna in Haungaroa is dominated by two species commonly found at many Kermadec volcanoes; the stalked barnacle *Vulcanolepas osheai* and the mussel *Gigantidas gladius*. The barnacles sit on rock surfaces, and with their white fan extremities they resemble little palm trees waving their fronds in the rising diffuse fluid flow. The *Gigantidas* mussels are hidden in rock crevices or, more often, are buried to two thirds of their length in sediments affected by low-temperature hydrothermal fluids. Besides these species we also collected *Vulcanidas insolata*, a mussel species that was previously only known from the Macauley and Giggenbach volcanos.

Our journalist joining the cruise for public outreach activities, Marie Heidenreich, writes daily reports of all the research activities, that take place onboard, and publishes them in the cruise blog geschichten.ptj.de/so253. The blog was created using the storytelling tool Pageflow, which enables the user to include not only texts and pictures, but also audio and video. This week we also published an English version of the blog, which will soon be completed: geschichten.ptj.de/so253-en. We also contributed several articles and Twitter tweets to the website of the German Science Year www.wissenschaftsjahr.de and the Federal Ministry of Education and Research BMBF.

As a storm NE of New Zealand formed a large wave front moving northwards towards our working area, we used an additional ROV dive to follow water column indicators for another hydrothermally active sits, which we could not locate, despite numerous hints of hydrothermal activity. As the weather conditions did not allow us to deploy the ROV for the next two days, we used the transit to our third working area Brothers Volcano to extend bathymetric mapping coverage by filling gaps in existing maps. The magnetometer was deployed simultaneously, which was interrupted by a shark attack on the instrument that caused severe damage to the sensor casing, but which did not stop further deployments.

Since our arrival on 7 January we have already carried out two ROV dives at the two cones of Brothers Volcano, albeit under difficult conditions due to strong underwater currents, although we were still able to collect some diffuse and hot fluid samples, and iron and manganese crusts. Two CTD-Tow-yos and two in-situ pump stations helped us to survey and sample the different plume layers originating from at least three different hydrothermally active sites. Since the weather has once again become too rough for ROV dives, we quickly changed plans this morning and transited to the neighboring (ca. 30 km to the NE) Kibblewhite volcano, for which evidence for hydrothermal activity also exist from former cruises. After mapping of the seafloor including a search for gas flare signals in the water column, we will try to locate the hydrothermal source with a towed CTD. After that, we will return to Brothers for the night program including CTD and Trace Metal Rosette stations and assume that tomorrow morning the weather will enable us to continue our ROV dive program.

With best regards from board RV Sonne on behalf of the whole science team of cruise SO253
Andrea Koschinsky (chief scientist SO253)