

Research Vessel POLARSTERN

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Punta Arenas - Port Stanley

Fifth Weekly Report: 06. – 12. May, 2019



White smoker and yellow sulphur of the Kemp Caldera

On Sunday, 5th May, we arrived at the Kemp Caldera, a prominent crater of volcanic origin at the southern end of the South Sandwich volcanic arc. The caldera, which has an average diameter of 7.4 km, has a depth of 1600m in its centre and has a wide rim with several secondary cones in 800-900 m water depth (Fig. 1). A younger volcanic cone rise up to about 200 m from the western bottom of the crater. A first measurement with the CTD sensors on Sunday, 5th May, over a known hydrothermal vent field confirmed, that hydrothermal activity was still present. Next to a distinctly increased turbidity, also increased temperatures and an anomaly in the redox potential of the water column near the thermal area was observed. On Monday, 6th May, we deployed a gravity corer and a multicorer half way between the caldera to the East and the segment E9 of the East Scotia Ridge to the West. In the night from Monday to Tuesday, a further CTD followed as well as seafloor survey with the OFOBS (Ocean Floor Observation Bathymetry System). On Tuesday, 7th May, at last we were able to conduct a long ROV dive in the Kemp Caldera with more than 11 hours on the seafloor (Fig. 2). We started the dive at the location “Great Wall”, which got its name from an altered hypabyssal rock covered at many places with either yellow sulphur or white bacterial mats. Single chimneys appeared to fully consist of sulphur and on breaking off sulphur pieces, the fresh yellow color of elemental sulphur became visible. We also saw sulphur in an area about 100 m to the Southeast known as “Winter Palace”. The sulphur dripped into the cold seawater in liquid form right in front our camera lenses, before it solidified into pearl-like structures.

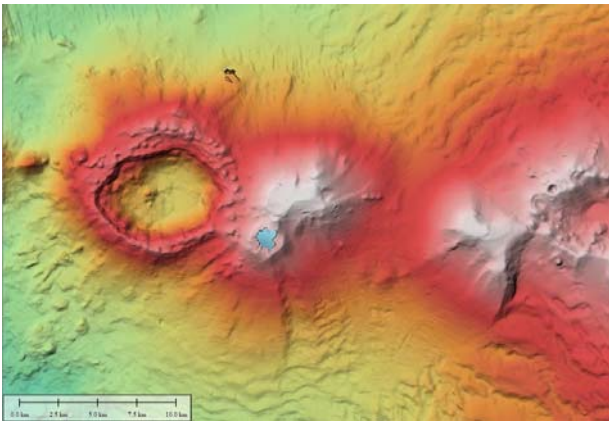


Figure 1: Composite bathymetric data from different sources show the Kemp Caldera (left) next to the Kemp Seamount and the Adventure Caldera (© Paul Wintersteller).



Figure 2: Technical pre-dive checks on MARUM QUEST before the ROV dived to the hydrothermal smokers of the East Scotia Ridge (©vdl).

The area is characterised by multiple white smokers, which cause a light turbidity of the bottom water (Fig. 3). With our fluid samplers, we collected the expelling fluids to analyse their chemical composition. The hot expelling fluids, which contains different components in solution and high concentrations, is mixing with the cold seawater. In this process, some of the components in solutions flock out, which on one hand build the smokers themselves and on the other form the light cloud cones. In general, these white smokers have a lower temperature than the black smokers do; and in white smokers, lighter minerals like anhydrite, opal and barite are precipitated while black smokers expel sulphidic minerals. What type of minerals the white smokers of the Kemp Caldera expel, we will only know after we have analysed the fluid and rock samples. The fantastic dive time, which was broadcast to numerous interested parties back onshore via the telepresence, was not only exciting on the seafloor but also on the bridge. From there, they watched a 700 m long table iceberg, about 2.5 nautical miles south of our ROV position, which slowly made its way

towards us and halfway throughout the drifted to a distance of only 1.6 miles and threatened us with an early abortion of the dive. Luckily, it changed its direction and passed the vessel on portside in a wide enough distance.



Figure 3: In contrast to the dark particle clouds of black smokers, white smokers expel light particles, which are built in lower hydrothermal temperatures on contacting seawater. (© MARUM).



Figure 4: Chemosynthetically living clams with erect siphons in the sediments of the Kemp Caldera, partially or fully burrowing (© MARUM).

As part of the scientific programme on this cruise, we are undertaking experiments to understand the biology of hydrothermal vent associated animals. In the Kemp Caldera we collected vesicomyid clams, *Laubiericoncha puertodeseadoi*, living in the seafloor sediments using the ROV *QUEST* and were able to bring the clams back to the ship alive and in good condition. The water temperature at the seafloor in the caldera is about 1 °C, but the volcanic influence makes the sediment warmer at about 5 °C. The animals were then divided into two temperature conditions, at 2 °C and 10 °C in the laboratory facilities on board, and experiments done to measure how their oxygen consumption might change in warmer conditions.

On Wednesday, 8th May, we sampled a sediment basin east of the rifting axis of the E9 segment, which was enclosed by magmatic rocks of two fault ridges. The impressive acoustic penetration of the Parasound system showed us a sediment layering of more than 50 m. With the piston corer we were able to collect almost 12 m of brilliantly layered sediments, which with a colorful mix of hemipelagic sediments with partially volcanic and hydrothermal components. Our geochemists were pleased by this, as they examined in several sediment cores how far these hydrothermal particles are transported away from the rift axis by the easterly current. On Thursday, 9th May, we left our southernmost work area for 2 days to investigate the ridge segment E5 for hydrothermal activities. This ridge segment, like E2 and E9, has a magma chamber that sits in relatively short distance to the seafloor so the existence of hydrothermal circulation with fluid orifices and further hot vent indicators on the seafloor are predictable. The highest probability to find new fluid orifices was in the investigation of an axial high in the central area of the rift valley. There we carried out a CTD and an OFOBS survey. Small anomalies of turbidity, as well as in the methane concentration, were present in general but not specific enough to be localised, so we decided not to search further for vent sites here. On the return journey to the Kemp Caldera, while surveying the seafloor on the western side of the back-arc rift axis, we passed an iceberg in close distance. When the first chinstrap penguins on the iceberg were detected, the emotions on board raised and our attention was unstopplable.

All on board are well. Best wishes in the name of all cruise participants,

Gerhard Bohrmann

FS POLARSTERN Sunday, 12th Mai 2019

The live-stream of ROV *QUEST* on RV *Polarstern* is available on: <http://vcedge1.marum.de/>