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Short Cruise Report
SONNE cruise SO271/1 (INDEX2019)
Port Louis (Mauritius) – Port Louis (Mauritius)
31.10.2019 – 18.12.2019
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Captain: Lutz Mallon

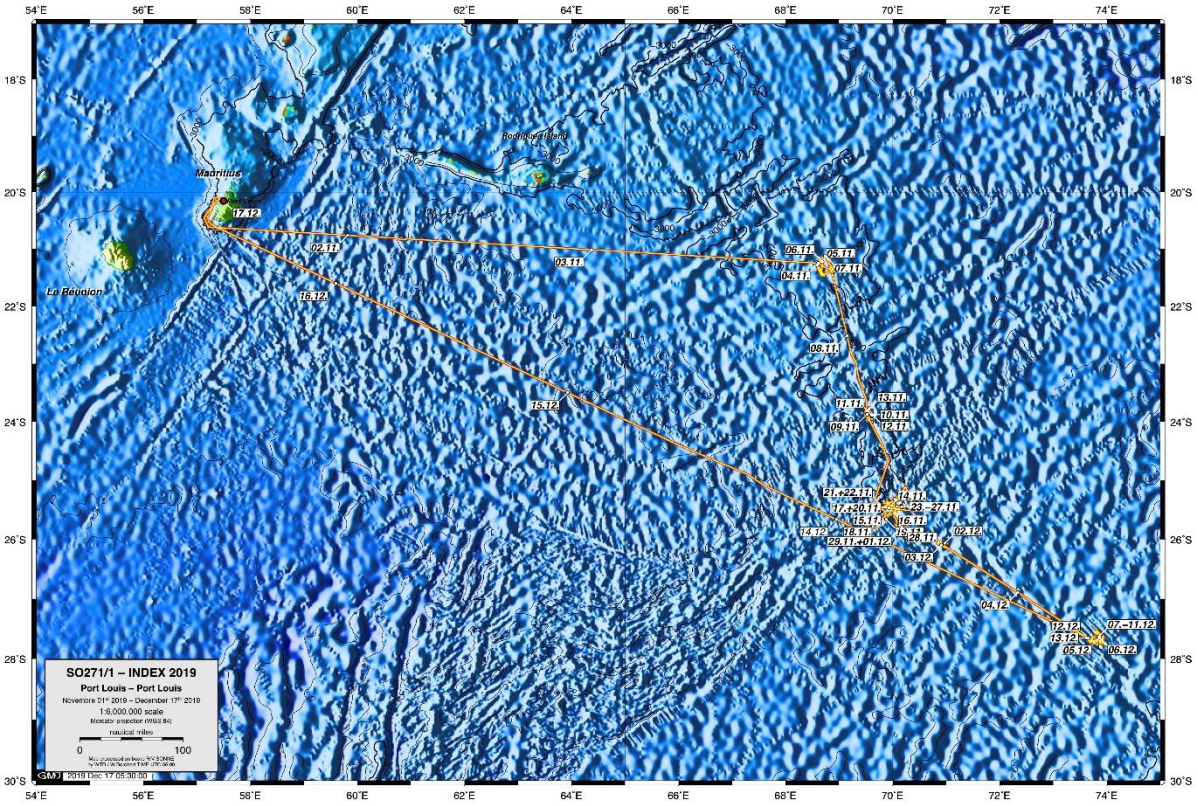

Fig. 1. Overview of the SO271/1 (INDEX 2019) working area, the cruise plot and courses along the southern Central and the northern Southeast Indian Ridge, Central Indian Ocean. The cruise started in and ended in Port Louis, Mauritius.

ABSTRACT

The expedition SO271/1 (INDEX 2019) of BGR with TFS SONNE targeted the German license area for polymetallic sulfides in the Indian Ocean. Cruise participants included the Universities of Hamburg, HCU Hamburg, Kiel, Erlangen, Padua, the DZMB Senckenberg Am Meer Wilhelmshaven and INES, and GEOMAR in Kiel. The cruise focused on the detailed bathymetric and geological exploration for active vents and inactive sulfide fields in the license clusters #01, #04, #05, #06, #07, #10 and #12. The license area was also sampled for environmental, i.e., (paleo) oceanographic, sedimentary and faunal base line studies by sediment coring stations, water sampling, biodiversity in the water column and in vent fields, and sediment trap and current meter moorings. Very few environmental and geological studies exist in this part of the Indian Ocean so far. Our work therefore contributes to the understanding of regional and ocean-wide oceanographic and sedimentation processes and to the faunal census.

Cruise SO271/1 (INDEX 2019) was very successful. Sea conditions were generally good with only a half day of limited operational capability. There were no problems with the ship operation despite the high number of different tools we deployed during the cruise and the limited space on SONNE's working deck. A total of 131 stations with survey, observation and sampling operations were completed in the license clusters #01, #04, #05, #06, #07, #10, and #12. A total of 12 different operational tools were used for diverse and extensive exploration and environmental studies during this cruise within the license area, including

- 6 vertical CTD rosette casts for environmental, water masses and sedimentary studies;
- 7 gravity corer and 3 multicorer stations for paleooceanographic and biogeochemical studies;
- 8 heat flow probe measurements for crustal temperature regime estimations;
- 24 wax corer and 15 dredge stations for petrological reconnaissance and spreading ridge and triple junction evolution studies;
- 10 sediment trap and two ADCP mooring operations for biogeochemistry, particle flux and ocean current measurements;
- 7 vertical multinet casts for planktonic base line studies in the license area. The biodiversity in total was studied and sampled with 4,125 samples and 5,477 individuals. 89 samples were collected for microbiological analyses;
- 20 deep-towed HOMESIDE surveys for high-resolution bathymetric mapping, magnetics and water anomaly surveys (total of 330 km, 202km² in 153 hours);
- 11 tow-yo stations with the SOPHI sensor sled for plume hunting (183 km, 116 hours);
- 18 ROPOS operations for detailed site surveys and sampling;
- bathymetric surveys with 938 hours of survey time (total of 4,541 km) with EM122 and 994 hours (4,828km) of survey with the echo-sounder EK60 for water column imaging and analyses.

Two new sites (SURYA, SOORAJ; both Sanskrit/Hindi for Sonne) were identified in the license clusters #06 and #07, respectively. SURYA is the very first identified vent site on the western flank of the entire SEIR. The new findings again attest to the high potential for sulfide mineralization in all clusters of the German license area. Additionally, 24 hydrothermal vent fluids were sampled from five different sulfide areas during the ROPOS dives and shipboard characterized. Swath bathymetric mapping and scientific echosounder measurements for water column imaging were carried out during the entire cruise outside the EEZ of Mauritius. The biodiversity was studied and sampled at 79 stations with 1972 sediment, rock, water and sulfide samples and more than 10,000 individuals.

The results with respect to the sulfide exploration during SO271/1 (INDEX 2019) are represented by

- the discovery of the SURYA sulfide area in cluster #06. The site extends over 40x40m and is composed of five sulfide sites with diameters of several meters. Two sites are inactive, three others show diffuse venting with fluid temperatures up to 32°C. The site is associated with the outer edge of a normal graben fault, similar to the setting that was identified at the NEW SONNE field in cluster #11. The location is situated about 6.8 km west of the central SEIR graben axis. The site is associated with a number of young pillow mounds. The graben fault plane is covered with talus material from the pillow mounds and the sulfide site, possibly covering parts of the site. Fragments of chimney debris and

frequent indications for former high-temperature venting were observed. The field is in the waning stage of venting with low fluid discharge temperatures. The normal graben fault shows outcrops of stockwork-type mineralization with highly altered pillow basalts and mineralized stringers in pillow volcanic talus and pillow basalt flows. The biodiversity is similar to other sites along the SEIR and at KAIREI. The scaly-foot gastropod *chrysomallon squamiferum* is also present.

- the discovery of the SOORAJ sulfide area in Cluster #7 extending over about 100x140m. The area is associated with a very prominent inner corner high and the association with exhumed deeper oceanic crust (megamullion or oceanic core complex), is suggested. The area is associated with redox, particle and self-potential anomalies, as well as a recorded plume. At least three vent sites and chimney-like edifices were located by high-resolution swath bathymetry mapping. The sulfide mound is flat and irregular and occurs on a gentle slope. A steeper slope occurs to the East. The inner corner high displays a generally rough terrain with slopes >40°. Similarities can be drawn to the KAIMANA field and its strongly fault-controlled occurrence of sulfide mineralization and chimneys, respectively.
- the discovery of vast extensions of the HUNA area in cluster #12. The size extends to about 2,400m length and a width of about 400m. In total, the Huna area hosts six high-temperature sites, 16 diffuse, low-temperature sites and 18 inactive sulfide patches.
- the significant extension of PENUMBRA (four more active vent sites, 2.6 x 0.5 km) and KAIMANA (three new sulfide sites) areas.

Cruise SO271/1 (INDEX 2019) attests to the high prospectivity of the spreading ridges in the Indian Ocean and of the German license area. The new discovery of larger and extending sulfide areas in two more clusters at greater distances from the actual spreading axes defines off-axis areas lacking high magmatic heat production and fluid pathways by traditional definition as new and prime exploration targets. Sulfide areas associated with exhumed deeper oceanic crust become a more significant exploration target as more sulfide sites are found.

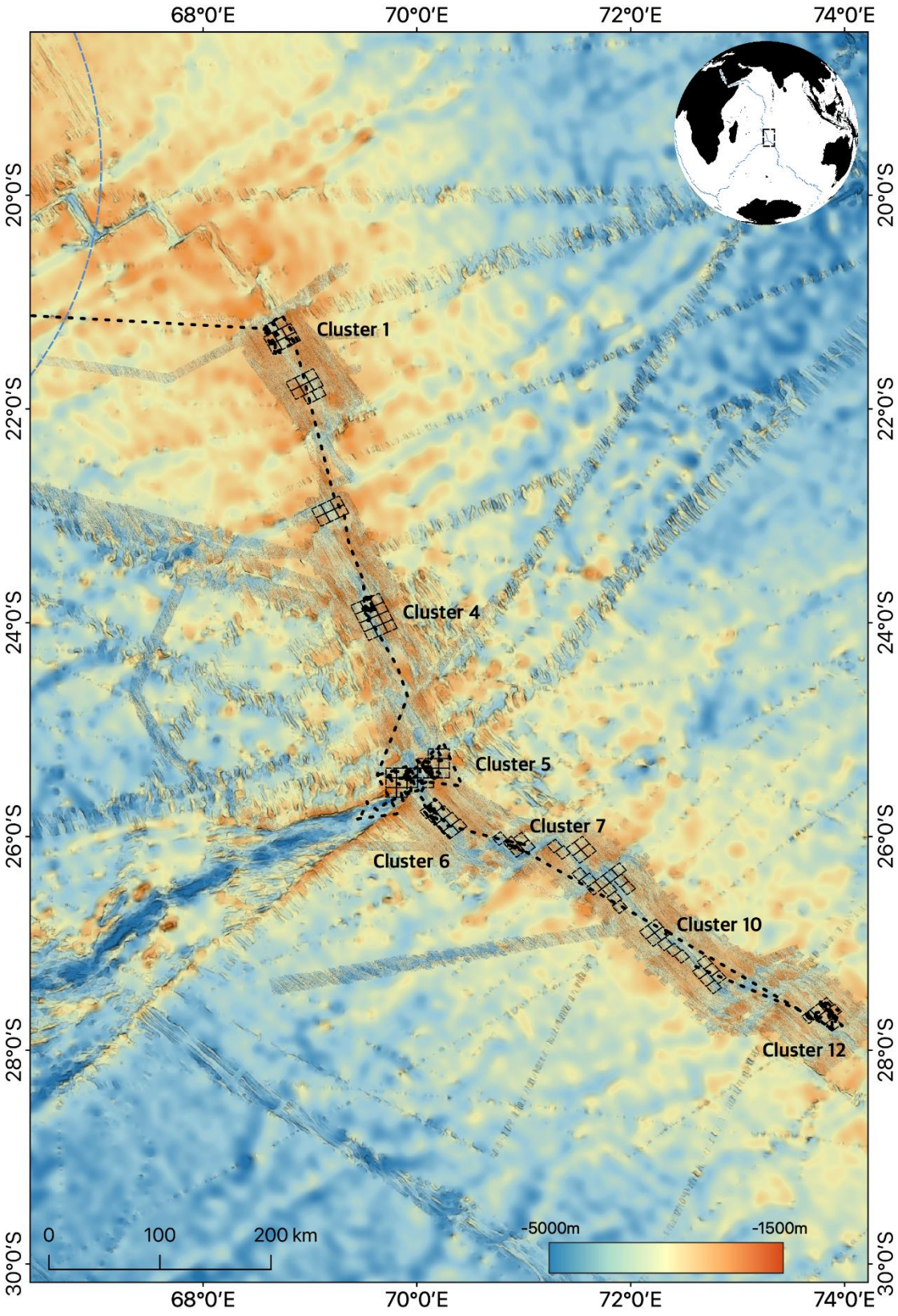

Fig. 2. Overview of the SO271/1 (INDEX 2019) working areas (from North to South cluster #01, cluster #04, cluster #05, cluster #06, cluster #07, cluster #10, and cluster #12) and courses along the southern Central and the northern Southeast Indian Ridge, Central Indian Ocean.

1. CRUISE NARRATIVE

Cruise SO271 (INDEX 2019) was very successful. Sea conditions were generally good with only half a day of limited operational capability during the first Leg. Ship and technical operations were generally unproblematic. A total of 131 stations with survey, observation and sampling operations were completed in the license clusters #01, #04, #05, #06, #07, #10, and #12 and twelve different operational tools were used for multidisciplinary diverse and detailed exploration and environmental studies in transit and within the license area, including six vertical CTD rosette casts for environmental, water masses and sedimentary studies, three multicorer and seven gravity corer stations for paleooceanographic and biogeochemical studies, five sediment trap plus current meter and one ADCP mooring recoveries and re-deployments for biogeochemistry, particle flux and ocean current measurements, eight heat flow measurements for the evaluation of crustal temperature distribution, 24 wax corer and 15 dredge stations for petrological studies of the ridge and Rodrigues triple junction evolution, ten sediment trap and current meter moorings and two ADCP moorings for biogeochemical studies and particle flux and current measurements, a total of 20 deep-towed HOMESIDE surveys for high-resolution bathymetric mapping, magnetics and water anomaly and self-potential surveys (total of 330 km, 202 km² in 153 hours), 11 tow-yo stations with the SOPHI sensor sled for plume hunting (183 km, 116 hours), 17 ROPOS dives for reconnaissance survey, mapping and sampling of active and inactive vent sites and sulfide fields (total of 112 hours bottom time), and 938 hours of bathymetric mapping (total 4541 km) with EM122 and 994 hours (4,828 km) of measurements in the water column with the echo sounder EK60. The biodiversity was studied in 4125 samples with a total of 5,477 individuals. 89 samples were obtained for microbiological studies. The cruise record with timing, station plan and station coordinates is presented in Table 3.1. Additionally, 27 hydrothermal vent fluids were sampled during the ROPOS dives and shipboard characterized. Swath bathymetric mapping and scientific echosounder measurements for water column imaging were carried out during the entire cruise outside the EEZ of Mauritius. The station locations are shown in Figures 3.1 to 3.8.

TFS SONNE arrived in Port Louis on October 28th and docked at 16:00 at Quay ALPHA (QA). First meetings with the ship's agent on that day and transportation to the vessel the following day. A meeting was held with the captain for logistics, container handling, lab occupation, scientific crew boarding. The docking head station for the Canadian ROV ROPOS was installed on the A frame by the ROPOS team. The first scientific meeting with all cruise participants was held in the evening. The other day, part of the scientific crew started with the ship's crew to unload the containers and store the scientific equipment. The containers and the lab equipment were delivered during noon and were taken aboard. First equipment to install and to mobilize was the Canadian ROV ROPOS on the after deck below the A frame. Heavy weight equipment including the plume sled SOPHI (PS), gravity corer (GC) multicorer (MUC) and multinet (MN) and their weights, HOMESIDE (HMS), sediment trap (ST) and ADCP equipment and anchors the wax corer (WC) and the dredge (DR) as well as various laboratory equipment were installed and unpacked. The Shipboard Scientific Party for cruise SO271/1 (INDEX2019) boarded TFS SONNE in Port Louis, Mauritius, in the morning of October 31st. All participants continued with equipment mobilization and lab installation. Scientific meeting and compulsory BGR safety instruction was held at 19:00 for the scientific crew.

Mobilization and lab set up continued the following day November 1st. The daily morning meeting routine at 08:30 was established, with the introduction of the scientists. At 10:20 (German) and 13:00 (English) the scientific crew received a safety introduction by ship`s officers. Equipment rearrangements and winch installation (mooring spill winch) occurred. A ROPOS deployment handling and harbor test was exercised at 15:00 (to 15:30) and followed by cruise preparation. The pilot arrived at 16:00 and SONNE departed at 17:15 and started the 684 nm transit to the first station (sediment mooring 01-03 in cluster #01). Travel speed was set at about 11 knots (2 diesel engines) and travel time was calculated to ~60 hours. The lab set up continued on October 2nd and a morning meeting occurred at 08:30 and a safety drill at 10:20. The weather turned very rough towards the afternoon. A first scientific introduction to the working area was presented at 19:00 (to 20:30) to the scientific party. The lab set up continued on October 3rd and the tools for the first stations (CTD, multinet, multicorer) were prepared. Following the regular meeting at 08:30, team meetings were scheduled for proper station management of the sediment mooring (ST) recovery and redeployment set up, the multicorer (MUC) design and set up, the multinet (MN) set up, and the planning of the sampling campaigns and experiment deployments for microbiology.

Another program meeting was held at 19:00. We left the Mauritian EEZ at 22:00 and the swath bathymetry system EM122, and the echosounder EK60 were switched on at 22:50 (UTC18:50). In the night to November 04th the time was shifted one hour to UTC+5 hours. Due to the weather conditions and several meters swell, the decision was taken to postpone the mooring recovery (01-03) to the following day.

We reached **cluster #01** and the first station *INDEX2019-001CTD* at 09:05 and started a vertical CTD water station for water masses reidentification at 09:15. Recovery was at 11:31 and sampling was successful. The station *INDEX2019-002MN* started our plankton survey in the license area at the same position at 11:44. The station ended at 14:50. The sulfide and biology team got a ROPOS introduction at 14:00 (to 15:30). Station *INDEX2019-003MUC* was deployed at the same position again for surface sediment sampling. The station started at 15:23 and ended at 18:05 with no significant rope tension release during the bottom contact (3,124m). The coring failed due to a tangled rope around the frame. The frame was damaged during the recovery of the MUC and the fixation was needed. We started for a SOPHI sensor sled tow along the intermediate western graben flank about 7 km off-axis. Station *INDEX2019-004PS* was deployed at 20:01 with the standard three maprs attached to the cable at 200m, 400m, 600m. The track started at 21:00. The tow continued to November 05 to 08:30 and SOPHI was recovered at 09:33, with 12 Niskin bottles filled and sampled. No plumes were detected during the 16 up-and-down profiles. Another ROPOS meeting occurred at 10:20 for ROPOS sample log (IRLS) orientation. Station *INDEX2019-005ST* recovered mooring 01-03. It started at 12:00 and the mooring was released at 12:09 with calculated 40 min for upfloat. The recovery at 13:55 was successful with the rotation schedule and current meter measurements completed successfully. Station *INDEX2019-006ROPOS* (R2119) was designed for ROPOS testing at a water depth of 45m only. The station started at 14:43 and ended successfully at 15:21. KIPS worked ok but one temperature sensor failed. Station *INDEX2019-007HMS* explored the western graben flank of cluster #01, about 11 km west of the spreading graben axis. The deployment started at 17:48 and the track at 19:11. The tow covered the entire 20km of survey with an average swath width of 600m. Right at the beginning it identified a pinnacle-shaped feature in the upper third of a gentle slope at about 2,600m water depth and on top of a rather flat mound. The pinnacle has a mound-like base and is about 30m high. No venting or self potential anomaly was recorded but the tow passed it 200m to the East. The remaining tow identified pillow mound-dominated morphologies and young volcanic edifices including a pouring lava lake volcano and a young potentially phreatomagmatic volcano with steep slopes (60°) and young talus deposits. The tow ended at 03:00 on November 06 and HOMESIDE was recovered at 04:07. Station *INDEX2018-008WC* started at 05:14 at the northern end of cluster #01 spreading axis on a young axial volcanic edifice. The bottom contact (3,402m) was at 06:19 and the wax corer was recovered at 07:23 with 5 out of 7 cups filled with fresh volcanic glass. The following station *INDEX2018-009WC* sampled a volcanic edifice close-by and started at 07:49. 6 of 7 cups were filled and an additional cm-sized block of plagioclase-phyric glass was recovered. The wax corer had bottom contact (3,252m) at 08:51 and was recovered at 09:51. Station *INDEX2018-010WC* started at 10:27 and sampled a younger volcanic cone developing into an elongated ridge south of station -009WC. Bottom contact (3,352m) was at 11:28 and the wax corer was recovered at 12:29 with 3 of 7 cups filled with a few tiny pieces of glass. Next station *INDEX2019-011ROPOS* addressed the pinnacle site identified during station -007HMS. ROPOS was deployed at 15:28 and reached seafloor at 16:25 (2,618m). After orientation an offset up to 200m were determined between ROPOS location and the map. Map orientation and navigation, however, were correct. It turned out that the pinnacles observed during station -007HMS actually represented artefacts from the HOMESIDE sled likely related to changes in the tool`s settings during the tow. The mound underneath the pinnacle artefacts represented a pillow mound, about 15m high and representing Mn-encrusted glassy basalts. The surrounding is heavily sedimented with only a few pillow blocks sticking through. The sediment is unstructured and not rippled but intensely bioturbated. Sessile sponges etc. are located on the basalt blocks and on the sediment. Few fishes to be seen. The WP2 on a smaller ridge turned out to be another glassy pillow ridge. Three basaltic blocks variably overgrown by a Mn-oxyhydroxide crust were sampled. In general the rocks show a fresh glassy appearance with limited indications for seawater alteration and no hydrothermal alteration. Sampling of five pushcores for pore water and biological studies. The dive ended at 18:47 (2,727m) and ROPOS was safely recovered back on deck at 20:42. Station *INDEX2019-012PS* started at 22:49 for a 30km long survey along the eastern flank of cluster #01, about 12.7 km off the spreading axis. The towpath started at

23:37 and was kept between 2,400 and 2,900m water depth. The area close to bottom (~50m above seafloor) showed again a higher particle density without any indications for hydrothermal plumes. The tow continued until 11:00 on Thursday, November 07. The station ended at 12:01 with SOPHI recovery. We continued with station *INDEX2019-013ST* for the redeployment of sediment trap/current meter mooring 01-04 (at the station of 01-03). The mooring anchored about 80m off the dropping point at 21°14.93'S, 68°35.25'E at a water depth of 3,145m. The length of the rope is 574m. Triangulation was carried out successfully. Afterwards, we headed for station *INDEX2019-014HMS* in the southeastern portion of the eastern graben flank about 10km east of the spreading axis in an area of young volcanism and cross-cutting spreading ridge structures. The tow included a starboard turn and little overlaps of the towlines. The station started at 18:43 and the tow started on the track at 19:53. It continued to November 08 at 05:06. A planned calibration circle could not be finished due to bad weather conditions. The tow identified series of volcanic ridges, pillow mounds and smaller volcanic edifices. There was, however, no indication for sulfide mounds or hydrothermal venting.

After the station, we left cluster #01 and headed to **cluster #04** for continuation of the exploration program. We conducted swath bathymetry mapping during the 14-hours transit to fill existing gaps in the regional bathymetric data. The planned antenna calibration for HOMESIDE surveys was postponed due to sea condition and the program in cluster #04 continued with station *INDEX2019-015WC*. It started at 20:10, reached bottom at 21:14 (3,536m) and ended at 22:18. The station retrieved 7/7 cups filled with fresh volcanic glass. Station *INDEX2019-016WC* addressed a volcanic cone at the northwestern edge of cluster #04, in the area of an axis overlap. It started at 23:11 and reached the bottom at 00:10 (3,339m) on November 09. The station finished at 01:17 with 3/7 cups filled with few small glass fragments. *INDEX2019-017WC* sampled a ridge in the same axial structure as station -016WC. Start at 02:00 and bottom contact (3,501m) occurred at 03:05. The station ended at 04:13 with fresh volcanic glass fragments in 3/7 cups. *INDEX2019-018WC* addressed another cone in the above axial structure. It started at 04:45, sampled at 05:48 (3,602m) and ended at 06:56 with a very small amount of glass fragments in 3/7 cups. *INDEX2019-019WC* sampled a volcanic cone at the northern rim of cluster #04. Start was at 07:27, bottom contact at 08:32 (3,402m) and end at 09:33, with 5/7 cups filled with variable amounts of volcanic glass fragments. The station *INDEX2019-020CTD* at the same position studied the water masses layers in the area of the sediment trap 04-04. It started at 09:44 in the axial area of the CIR at the elevation of the EGS sulfide area. The cast to 3,000m water depth reached deepest point at 10:59. 24 water bottles were tapped successfully and the CTD reached surface at 12:12. The following station *INDEX2019-021MN* occurred at the same position as -020CTD and sampled plankton from the identified five different water masses. Start at of the station was at 12:51 and the 3,000m were reached at 14:12 with the first sampling. The multinet was recovered at 15:51. Sampling was successful and all nets closed but #1 and #2 had zipper problems. It was followed by station *INDEX2019-022WC* for the sampling of a volcanic edifice from the axial area of cluster #04. The station started at 16:29, the wax corer reached bottom (3,412m) at 17:31 and was recovered at 18:34. Sampling retrieved only a small amount of sediment without volcanic glass. Station *INDEX2019-023WC* sampled an elongated ridge in the axis near the segment center. Start was at 19:09, the bottom was reached at 20:19 (3,791m) and the wax corer was recovered at 21:30 with 7/7 cups filled with fresh glass. Additionally, two larger cm-sized basalt fragments with glassy crusts were retrieved. Station *INDEX2019-024WC* addressed a volcanic edifice to the south of station -023. Start was at 22:13 and the bottom was sampled at 23:15 (3,496m). After recovery at 24:11 (Sunday, November 10), 4/7 cups had small amounts of glass. Station *INDEX2019-025WC* started at 00:45 and addressed another axial volcanic edifice further to the south. The bottom was sampled at 01:53 (3,672m). After recovery at 03:02, the wax corer failed sampling and no sample could be retrieved. The petrological sampling program of the axial area of cluster #04 was followed by the recovery of the 2,843m-long mooring 04-04 (3x sediment trap, 3x current meters) at station *INDEX2019-026ST*. The station started at 05:05 and ended with the successful recovery at 09:43. The shallow sediment trap was recovered with 16/20 cups filled, the intermediate with 20/20 and the deep trap with 15/20 cups filled. Two passive samplers were lost. The program continued with station *INDEX2019-027ROPOS* for the revisit of the active Edmond vent field for chimney (fluid, sulfides) sampling, the deployment of biological experiments in the active and inactive portions of the field and a reconnaissance dive towards the associated collapse structure to the NNW and beyond. Deployment was successful at 10:30 but an oil spill from the starboard thruster made the recovery necessary. Repair for three hours and redeployment at 13:38. ROPOS reached seafloor at 16:11. Edmond was redefined, a larger chimney edifice was sampled in 0.5 m parts only, coming from the original 417°C chimney

location from INDEX2013. Open orifice and the chimney fragments have a high volume of chalcopyrite plus variable amounts of pyrite and sphalerite. Anhydrite is not obvious. Only few vent species were associated with the chimney. Exit temperatures were determined to 352°C. An incubator and amphipod trap were installed. Several vent species were sampled including fish, gastropods, microbial mats. ROPOS left bottom at 18:10 and was successfully recovered at 20:35. HOMESIDE station *INDEX2019-028HMS* carried out calibration of the Sonardyne RANGER 2 USBL antenna. Station started at 21:12 and ended at 02:10 the next day at 02:10 on November 11. The tow successfully acquired the complete data set. Subsequent station *INDEX2019-029MUC* aimed at the sediment sampling close to the mooring position 04-04. The station started at 02:40, with a bottom contact at 04:16 (3,623m) and ended at 05:32. The MUC did not release and no samples were obtained. We repeated the station with *INDEX2019-030MUC* for sampling and after deployment at 05:36, bottom contact at 06:46 (3619m) and MUC recovery at 07:54, no samples were recovered due to another malfunction. Following station *INDEX2019-031ROPOS* aimed at the definition of the southeastern extension of the inactive SCORE field as a follow-up study of former video sled tows (INDEX2015). Deployment was at 08:51 and first bottom sight was at 11:19 (3164m). Sampling included oxidized sulfide chimney fragments, surface sediments, diffuse vent fluids, and basaltic host rocks. Two more incubators were set out in the inactive SCORE field and the unmineralized areas. The dive ended in the active Edmond field and the amphipod trap was recovered safely. Last bottom sight was at 17:56 (3261m). ROPOS was safely recovered at 20:17. Station *INDEX2019-032HMS* addressed the first part of detailed high-resolution mapping of the ALPHA area. The deployment started at 21:17 and the track was started at 22:23. We continued the two tow lines to the morning of Tuesday, November 12. The tow reidentified the field α3 by water column imaging, bathymetry and self-potential measurements. The tow also identified two new potential sites within the ALPHA area. The track ended at 03:48 and HOMESIDE was recovered at 04:46. Dive *INDEX2019-033ROPOS* explored the outer limits of the inactive GAUSS field to the NNW of EDMOND. The deployment started at 08:16 and first bottom sight was at 10:21 at 3017m. The dive explored the area and increased the size of GAUSS. Several observations of reddish colored sediments from INDEX2015 were identified as sedimented sulfide areas. Oxidizing sulfides are also overlain by transported talus material indicating an age of GAUSS with respect to EDMOND. It is evident that GAUSS and SCORE occupy the same normal fault along the eastern graben flank while EDMOND sits on a younger (?) and subparallel structure towards the spreading axis. GAUSS extends for some additional hundred meters to the North and West of the former limits. Samples included (oxidized) sulfides, old chimney fragments, push cores (with pyrite occurring on the bottom of a 26cm long core), crusts. ROPOS left the seafloor at 17:36 (3,023m) and was recovered at 19:45. The station *INDEX2019-034HMS* continued and finished the high-resolution bathymetric mapping of the ALPHA area with a third NW-SE profile and two cross-cutting lines (NE-SW). HOMESIDE was deployed at 20:31 and the tow started at 21:43. All known sites from the INDEX2015 survey were reidentified plus two new sites. The first has a prominent redox and pH anomaly and lies few hundred meters (500m) outside the cluster #04 in the NWern extension. The second shows a strong redox anomaly. All four new sites will be studied in greater detail during following exploration cruises. The tow ended at 07:07 on November 13 and was continued with a calibration circle for the onboard magnetometer. HOMESIDE was recovered at 10:58. The program continued with the deployment of mooring 04-05 during station *INDEX2019-035ST* at the same position as mooring 04-04 (start at 13:00). Mooring 04-05 has a total length of 2,843m and carries three sediment traps, three current meters and two BGR passive samplers. The anchor was dropped at 17:05 at a water depth of 3,590m. The triangulation ended at 19:00 and the mooring was positioned at 23°52.45'S/69°31.11'E and at 3,593m water depth. After the deployment we continued with the transit to cluster #05 including two planned shipborne swath bathymetry mapping lines in between clusters #04 and #05 (6knts) and along the western border of the southern sulfide blocks of cluster #05 (4knts). Due to temporal constraints, we postponed the second line in the westernmost cluster #05 in order to reach the ROPOS dive position at the KAIMANA vent field.

Station *INDEX2019-036ROPOS* on the KAIMANA area in license **cluster #05** started at 08:15 on November 14 and had first bottom sight at 10:26 (2,744m). The dive reidentified the inactive site just NW of the known active sulfide mound. The dive surveyed two active and one inactive site. One active site was identified during a HOMESIDE tow during INDEX2018 but could not be reached due to A-frame load. We were able to increase the size of Kaimana significantly but still missed another active site due to time and dive schedule. Sampling was successfully carried out with the recovery of an entire chimney edifice (pushed for fluid samples in 2018), pushcores, diffusive fluid and water samples, the vent fauna

and different sulfide and host rock samples. ROPOS left bottom at 17:37 (2,954m) and was safely recovered at 19:55. This was followed by station *INDEX2019-037HMS* to add a high-resolution swath bathymetry line to the existing lines from INDEX2018 and survey for downslope extensions of the field towards the axial region. HOMESIDE was deployed at 20:37 and started the track at 21:07. Minor self-potential anomalies were recorded at faulted, steep, mound-shaped morphologies. The profile was abandoned at 23:27 due to technical problems (ship`s Posidonia system, portside Rx of Homeside) and failure of the bottom detection. The program was changed to the first wax corer stations in cluster #05. Station *INDEX2019-038WC* addressed an elongated axial ridge towards the northern end of cluster #05. The wax corer was deployed at 01:21 on Friday 15 and reached bottom at 3,994m water depth at 02:30. The corer recovered glass particles in 1/7 cups and the station ended at 03:44. The following station *INDEX2019-039WC* sampled a single volcanic cone on the CIR axis. The station started at 04:28 and reached bottom at 05:38 (3,818m). The recovery was at 06:51 with 4/7 cups filled with fresh volcanic glass. The following dive *INDEX2019-040ROPOS* addressed the area east of KAIMANA to survey its extension towards the graben axis. ROPOS was deployed at 08:10 and reached bottom at 10:29 (2,969m). A third and small fourth active vent site (high T and diffuse) was identified on the deeper flanks of the KAIMANA area. The size of the KAIMANA extends for >1000m and is strictly fault bound on faults with two different orientation perpendicular and at a high angle to the orientation of the spreading graben axis. Faults are characterized by alignments of dead chimney edifices. It can be interpreted that KAIMANA actually represents a waning system. The dive recovered sulfides (high cpy, with blackish portions of magnetite/pyrrhotite), host rocks (gabbros, pyroxenites) and a representative collection of the vent community plus bacterial mats. ROPOS left bottom at 17:40 (2,958m) and was safely recovered at 19:53. Subsequent station *INDEX2019-041HMS* addressed the wider KAIMANA area and added another line to the high-resolution mapping. HOMESIDE was deployed at 20:35 and the tow started at 20:35 (2932m). The tow repeated the scheduled profile from the abandoned tow the day before and could not reidentify the weak signals. The station was successful and added a 15km long line indicating roundish features (pillow mounds, exhumed serpentinized intrusives ?) and debris from the upper western graben flank. Sediment layers seem to be rare. The tow extended almost to the center of the triple junction and allowed better positioning of subsequent wax coring, and dredges. On November 16, the station ended at 05:28 and HOMESIDE was recovered at 06:43. Subsequent dive *INDEX2019-042ROPOS* addressed the northward extension of the KAIMANA field and the recovery of sulfide and host rocks variations plus the recovery of an amphipod trap from the day before. The dive started at 08:14 and reached bottom at 10:19 (2,947m). The dive again added new ground and sulfide edifices to the known KAIMANA size and better constrained its alignment along prominent fault systems. The northern end is still obscured by overlying talus material. The host rocks all represent intrusive rocks (gabbros, pyroxenite), variably altered/metamorphosed to serpentinite-bearing rocks. Pyroxene (and plagioclase), however, in part are still pristine and the serpentinization process is related to structural exhumation rather than to hydrothermal alteration. The sulfides are very copper-rich and locally quite pyritic. Beside the alignment along faults, there exist small (10ms) patches of (active) sulfide vents. Trap recovery and biodiversity sampling was completed. ROPOS left bottom at 17:21 (2,582m) and was safely recovered at 19:22. Station -042ROPOS finished and completed this year`s survey of the INDEX2018 KAIMANA area. Following station *INDEX2019-043PS* surveyed the northern so-called sulfide block covering the CIR axis and the first western ridges of the graben flank over a distance of 11km. SOPHI was deployed at 19:53, with three maprs on the cable at 200/400/600m, and started the track at 21:01. The station finished the entire 11km tow track successfully on Sunday, November 17. Plume signals (particles, redox), however, were not recorded. The tow ended at 03:46 and SOPHI was recovered at 05:07. After a two hours transit to the (south)western sulfide blocks of cluster #05, we started a swath bathymetry single line survey to fill the last gap in our cluster and license area at about 07:10. The four hours bathymetry survey covered a distinct part of the SWIR outside the cluster but prepared the petrological sampling with subsequent dredges. The easternmost SWIR lacks any information on young magmatic/volcanic activity and was never sampled. We aimed at the identification of young volcanism in the area close to cluster #05 in order to elaborate the magmatic evolution of the Rodrigues Triple Junction, and its potential effect on the thermal regime and associated hydrothermal activity. Sampling started with station *INDEX2019-044DR* in the center of the SWIR graben, about 20 km west of cluster #05. The station sampled a small axial ridge @69°44. The station started at 13:09 and the first bottom contact was at 14:22 at 3,827m. The dredge left bottom at 16:56 (3,729m) and reached the water surface at 18:12 with ~275kg of very variable rocks including coarse-grained gabbros, pyroxenite/peridotite, both types variably serpentinized, and young volcanic glass. The glass indicates

young volcanic activity in this eastern portion of the SWIR for the first time. Station *INDEX2019-045DR* sampled the upper portions of the steep northern flank of SWIR, representing older CIR crust dissected by SWIR material. The dredge started at 19:22 and reached bottom at 20:17 (3,043m). It left seafloor at 22:53 (2,425m) with a maximal rope tension of 8.12t. The dredge was recovered at 23:47 with about 350kg of various intrusive(?) and volcanic rocks. Pillow fragments carry fresh volcanic glass. Next station *INDEX2019-046DR* on Monday, November 18, sampled a deep axial ridge to the East of the earlier stations but along the eastern portions of SWIR towards the triple junction. The station started at 01:03 and the dredge reached seafloor at 02:21 (4,055m). The dredge left bottom at 04:13 (3,445m) and reached surface at 05:21 with ~250kg of holocrystalline and partly talus basalt. Few pieces of volcanic glass were collected. The station *INDEX2019-047DR* addressed a small ridge in the deep basin of the SWIR close to the RTJ. The station started at 06:30 and reached bottom at 08:00 (4,903m). Last bottom contact was at 09:53 and the dredge returned to deck at 11:15 without samples. Subsequent station *INDEX2019-048CTD* down to a water depth of 4,809m identified the water masses and water properties in the deeper part of the SWIR. The CTD reached the deepest point at 13:34 (4,818m) and sampled 24 water bottles out of water depths between 4,807 and 800m. The station ended at 15:21. Station *INDEX2019-049CTD* was a follow-up water survey for surface waters down to 700m water depth. The station started at 16:06, reached the 700m water depth at 16:28, and was recovered at 16:58, with all 24 bottles filled. We carried out station *INDEX2019-050MN* at the same position for a zooplankton study in the SWIR. The station started at 17:02 and reached it deepest point at 19:39 (4,599m). A total of nine samples were taken during its recovery from different water depths between 4,599 and surface water. The station ended with successful sampling at 22:09. The next station *INDEX2019-051DR* sampled a small axial ridge at the easternmost end of the SWIR. The station started at 23:18 and reached seafloor on November 19 at 00:27 (3,703m). Dredge progress was successful and the dredge left the bottom at 01:46 (3,621m). It was recovered at 03:09 with ~25 kg of reasonably fresh aphyric basaltic rocks. The subsequent station *INDEX2019-052DR* sampled the upper flank of the northern rim of the SWIR graben flank along the profile of stations 051-052-053. The sampled material represents older CIR crust. The station started at 03:43 and the dredge reached seafloor at 04:39 (3,012m). The last bottom contact was at 06:40 (2,667m) and the dredge recovered (07:10) about 400kg of various volcanic rocks including pillow fragments with reasonably well preserved volcanic glass. Station *INDEX2019-053DR* sampled the uppermost southern flank of the easternmost SWIR along the profile. The rocks represent SEIR crust close to the RTJ. The station started at 07:59 and reached bottom at 08:45 (2,150m). Dredging was successful and the tool left seafloor at 10:59 (1,791m). It recovered about 350kg of holocrystalline basaltic rocks showing columnar jointing and variable seawater alteration with reddish colors. Few glass samples were observed. The station *INDEX2019-054PS* was a SOPHI tow along the western CIR graben flank some 6.5 kilometers off the axial CIR spreading graben structure and 3.5 km east of the KAIMANA site. The station started at 13:53, the tow at 15:13. It ended at 22:15 and SOPHI was back on deck at 23:22. The first deployment was abandoned because of sensor failures. The tow had a length of 19km (10.2 nm) and recorded no plumes. Station *INDEX2019-055HMS* addressed an area about 1.7 km northeast of KAIMANA field. In 2018, medium-sized anomalies in redox and turbidity were identified and their origin had to be clarified. The tow also closed gaps in HOMESIDE bathymetric mapping. HOMESIDE was deployed on November 20 (Wed.) at 00:41 and the track started at 01:35. It ended at 06:12 and the tool was recovered at 07:08. A prominent redox anomaly in the beginning in two maprs along the cable at a water depth of ~2,345m could be attributed to KAIMANA origin. Along the 10km long tow no other anomalies were identified. Station *INDEX2019-056ROPOS* addressed an area of a first dive during INDEX2018. The area was prime target during INDEX2018 because of a number of water column anomalies. The first dive was unsuccessful and only identified outcrops of intrusive deeper CIR oceanic crust and variable coverage by manganese nodules/crust. The following dive in 2018 was KAIMANA and no more dive was carried out in this more central part of Cluster #05 West. The dive started at 08:12 and first bottom sight was at 10:08 (2,600m). The survey along the ~3km long transect identified sedimented areas with frequent Fe-Mn nodules on top and intercalated outcrops and talus rocks of intrusive origin. Pillow basalts were not identified. A variety of different lithologies and intrusive facies were sampled. There was no evidence of any active or extinct hydrothermal activity. The dive left bottom at 17:50 (2,595m) and ROPOS was safely recovered at 19:47. The subsequent station *INDEX2019-057HMS* targeted a small anomaly in self-potential measurements at mound-like features in the same region. HOMESIDE was deployed at 20:43 and the track started at 22:02 to the other day November 21. The 14 km of high-resolution bathymetry identified a younger volcanic caldera feature and roundish mounds, with highly fractured plateau-like areas. The anomaly could not be verified nor

any indications for sulfide occurrences or hydrothermal venting. The tow ended at 04:21 and recovery was at 05:35. Station *INDEX2019-058ROPOS* addressed the mounds at the western end of cluster #05, named Green Rock Hill for the occurrence of strongly serpentinized mafic-ultramafic intrusive rocks. The dive addressed petrological sampling and a site survey for active or extinct hydrothermal activity. ROPOS was deployed at 08:13 and reached bottom at 08:15 (2,884m). The area is characterized by 200-250m high ridges built of strongly altered/weathered/ serpentinized gabbronorites and pyroxenites. Pelagic sediments, numerous talus deposits and Fe-Mn oxyhydroxide crusts (nodules) cover large parts of the area but steeper fault zones expose cliffs of outcrops. Various rock samples for magmatic facies identification, crusts and biological samples were obtained. The area dos not show any evidence for hydrothermal activity nor extinct vent sites. The dive left seafloor at 17:44 (2,760m) and ROPOS was recovered at 19:50. Following station *INDEX2019-059WC* addressed a young volcanic edifice for volcanic glass sampling. The wax corer was deployed at 20:26, reached seafloor at 21:24 (3,213m), and returned to deck at 22:22 without any glass samples. The recovery of few sediment material and Mn encrustations indicate that the targeted edifice was sediment-covered. Station *INDEX2019-060WC* addressed another young volcanic edifice for volcanic glass sampling. Deployment was at 23:18 and the corer reached bottom at 00:07 (2,624m) on Friday, November 22. After recovery at 00:59 only very few amounts of glass (if any) could be sampled, probably due to sediment coverage. Station *INDEX2019-061GC* sampled a wider regional basin at the transform fault and towards the OCC just north of the cluster. The station started at 01:44 and the gravity corer (4-m-length) reached the bottom at 02:53 (3,674m). The recovered core has a length of 3,75m and a silty-clayey composition with clay becoming the prominent grain size towards depth. The gravity corer was successfully recovered at 04:05. Subsequent station *INDEX2019-062HF* measured the heat flow at station -061GC. Station started at 07:34 but the heat flow probe had to be brought back on deck due to communication loss. A connection cable suffered from a shortcut and after successful replacement, the station was redeployed. The first bottom contact was at 11:57 (3,649m) and after two successful temperature gradient measurements (all thermistors in sediment), the probe left bottom at 12:28 (3,657m). The heat flow was measured at 95.2 mW/m² with a thermal conductivity of 0.9W/m°C. It was safely recovered at 13:42. Station *INDEX2019-063WC* addressed a prominent volcanic cone in the central area of the western CIR crust, about 7km west of KAIMANA. The station started at 15:06 and the corer reached bottom at 15:55 (2,679m). No cups were filled and only few amounts of sediments were recognized after recovery (16:46). Station *INDEX2019-064DR* sampled a series of flat topographic highs (ridges?) along the easternmost tip (axis?) of the SWIR (1st segment). The dredge was deployed at 17:41 and reached seafloor at 18:52 (3,931m). It left seafloor at 20:40 (3,712m) and was recovered at 21:44 with three pieces (~4 kg) of fresh porphyritic (plagioclase, olivine) basalt, in parts covered by a porphyritic glass crust. The sample possibly represent the first and youngest basalt equivalent from the 1st segment of the SWIR. Station *INDEX2019-065DR* addressed a small ridge at the southern end of the CIR domain on its western flank. It marks the offset between the CIR and SEIR. The dredge was deployed at 22:44 and reached bottom at 23:44 (3,376m). Only a few marks were recognized during the dredge tow. The dredge left bottom at 01:06 on November 23 (3,075m) and was recovered at 02:00, with about 200kg of angular blocks and porphyritic basalt fragments. Station *INDEX2019-066WC* sampled a volcanic cone on the CIR axis. Start was at 02:40 and the wax corer reached the bottom at 03:52 (4,088m). The station ended at 05:08 with only very few pieces of volcanic glass. Station *INDEX2019-067WC* addressed a volcanic cone in the axial area of the southernmost CIR close to the RTJ. The sampling started at 05:47 and the wax corer reached bottom at 06:56 (3,848m). Recovery was at 08:06 with 7/7 cups filled with fresh volcanic glass and additional pieces (up to 5 cm) of glass on the weight. Station *INDEX2019-068ADCP* recovered the ADCP mooring 05-02 from station INDEX2018-037ADCP. The mooring was released at 09:08, reached surface at 09:30 and was safely recovered. Station *INDEX2019-069PS* addressed the southeastern extension of the KAIREI – hosting, NW trending ridge at water depths between 2,400 and 2,800m. It covers the area 13.2 km east of the CIR spreading axis. It started at 11:03 and the tow at 11:57. No plumes were recorded along the 14.7km long tow track. The tow ended at 17:97 and SOPHI was recovered at 18:01. We continued with a transit to the eastern rim of the license cluster and with swath bathymetry mapping of the area in order to finish the bathymetry mapping of the German license cluster. During the survey, the water column above KAIREI and KAIMANA was studied for indications of the existence of their hydrothermal plume. We continued the swath bathymetry mapping to November 24 and started a HOMESIDE survey SE of KAIREI for detailed maps in the area (station *INDEX2019-070HMS*). Start at 07:08 and of the tow at 07:32. A total of 32,2 km² were mapped with high-resolution bathymetry in three lines trending SE-NW. A prominent feature includes a cross-

cutting graben-like basin with sharp horse-tail-like faults in the central part of the survey. The graben trends roughly in the direction of the southern end of the overlapping CIR spreading center at the southern end of the northern CIR segment. The faults are lined by mound-shaped features which represent rotated blocks of basaltic dikes. Towards KAIREI, the plume becomes more prominent. The tow ended at 06:11 on Monday, November 25, and HOMESIDE was recovered at 07:07. The map adds to the VICTOR map from cruise INDEX2016_1. Start of station *INDEX2019-071ROPOS* at 08:17 for the survey of the secondary graben from station -070HMS. Bottom was reached at 10:33 (3,111m). The fault-bounded mounds and blocks do represent rotated blocks of basaltic dikes or sills. Sulfides were not observed. The sampled rocks are highly vesicular and represent pillow samples and phyric basaltic material from volcanic ridges, with talus-covered steeper slopes. The bottom was left at 17:39 (3,117m) and ROPOS was recovered at 19:59. Station *INDEX2019-072HMS* surveyed the NW-SW of KAIREI to complete the detailed high-resolution bathymetry in that area. 9.9 km² were mapped in three lines and showed volcanic ridges and fractured pillow volcanoes. Start of the survey at 20:48 and of the tow at 21:48. The KAIREI plume was nicely picked but there were no further indications for any new sulfide area. The tow ended Tuesday, November 26 at 05:53 and HOMESIDE was recovered at 06:53. Station *INDEX2019-073ROPOS* addressed the very detailed survey of the inactive part of KAIREI for video mosaicking and site survey for trench cutter experiments. Along 24 NW-SE lines with a distance of ~12m in between, the site was videoed and photographed in detail. A detailed mosaic is necessary to prepare the trench cutting experiment planned for 2023 (potential drilling sites). The dive started at 08:12 and had first bottom sight at 10:03. The 24 lines were finished at 17:57 and ROPOS was safely recovered at 19:36. The station *INDEX2019-074PS* addressed the NE-most sulfide block of cluster #05, aligned with the next northern spreading axis in this overlapping spreading zone area. It covered 14 km and finished 12.2 km. SOPHI was deployed at 23:45 and the tow started at 24:59 on November 27. Technical issues in SONNE`s engine room (front propeller`s hydraulic problems) hampered an earlier start. The tow station continued to 05:36. SOPHI was recovered at 06:58. No evidences for plumes were discovered. The redeployment of the ADCP close to the KAIREI field occurred during station *INDEX2019-075ADCP*. The start was at 09:36 and the anchor (wagon wheel) was dropped at the same time. The ADCP was triangulated at 10:05 (25°19.3; 70°02.3, 2,570m). The station *INDEX2019-076GC* for sediment sampling was performed on the southeastern most corner of cluster #05. The gravity corer was deployed at 13:57 and reached bottom at 15:09 (3,680m). The station ended at 16:22 with the recovery of 162 cm of dense silty clay, sand, with eight layers of fragmental basaltic glass fragments. *INDEX2019-077HF* performed a heat flow survey at the same position as station -076GC. The station is almost equidistant to the spreading axis and station -062HF.The station started at 17:30 and reached bottom at 19:11 (3,683m). Two successful penetrations and one heat conductivity measurements by a heating experiment was performed. All thermistors along the 2m-long lance penetrated the sediment. The heat flow was determined at 79.6mW/m² with a thermal conductivity of 0.94W/m°C. The heat flow probe left bottom at 19:48 and was safely recovered at 20:57.

After this station, we left cluster #05 for license cluster #06. Station *INDEX2019-078WC* was deployed on Thursday morning, November 28 on an on-axis cone at the southern extremity the CIR and in the RTJ area. The corer was deployed at 00:11 and reached bottom at 01:20 (3,934m). It was recovered with two small glass pieces at 02:30. Station *INDEX2019-079WC* addressed an axial volcanic cone in the RTJ area. Deployment was at 03:15 and the corer reached bottom at 04:29 (4,127m). Recovery was at 05:48 with only few fragments of glass. The following station *INDEX2019-080WC* addressed a small, NW-SE orientated ridge at the northernmost end of the SEIR. It started at 06:55 and reached seafloor at 3,686m at 08:02. The recovery was at 09:07 with very few small shards of glass in only a single cup. It also recovered a small amount of sediment and Fe-Mn-oxyhydroxide crust.

Station *INDEX2019-081PS* addressed the NW half of **cluster #06** for plume reconnaissance along a 16km long towpath. SOPHI was deployed at 12:44 and the track started at 13:45. The tow ended at 19:44 and SOPHI was recovered at 21:02. No plumes were discovered in neither SOPHI nor in the maprs. Station *INDEX2019-082HMS* surveyed the NW portion of the cluster along the outer edge of the cluster. It covered an outer terrace of the western SEIR flank. Deployment of HOMESIDE was at 23:04 and the track started at 24:04 on early Friday, November 29. HOMESIDE covered 9.64 km² along a 17.9 km long line parallel to the western graben faults. A series of fractured volcanic ridges and minor pillow mounds were mapped at the start and in the end of the tow. Different fault systems seem to be responsible for the bending of the terraces. Mound-like domes are located on an internal fault of the

terrace. A prominent series of pillow volcanic mounds show active venting, and HOMESIDE detected a distinct plume in the water column, associated with self-potential anomalies, at a water depth of ~2,900m. The site is associated with the outer edge of a normal graben fault, similar to the setting that was identified at the NEW SONNE field in cluster #11. The site is associated with a number of young (?) pillow mounds that do not show any sediment dusting. The graben fault plane is covered with talus material from the pillow mounds and the sulfide site, possibly covering extensions of the site. No other indications for venting of inactive sulfide sites were identified. The tow ended at 07:06 and HOMESIDE was recovered at 08:07. Subsequent station *INDEX2019-083ROPOS* targeted the vent site identified during station 082HMS. The location is situated about 6.8 km west of the central SEIR graben axis. The dive started at 09:19 and reached bottom at 11:17 (2,934m). The dive confirmed the vent site. Fragments of chimney debris and frequent indications for former high-temperature venting were observed. The field is in the waning stage of venting at 32°C being the highest fluid discharge temperature. The normal graben fault shows outcrops of stockwork-type mineralization with highly altered pillow basalts and mineralized stringers in pillow volcanic talus and pillow basalt flows. The sampled sulfides are rich in pyrite but show chalcopyrite-sphalerite mineralization. Stockwork samples in mineralized talus have open void fillings with carbonates and silica. The site is small, about 40x40m in size. The biodiversity is similar to other sites along the SEIR and at KAIREI. The scaly-foot gastropod is present. The vent site was named after the Hindi/Sanskrit word for SONNE, SURYA. Station *INDEX2019-084PS* addressed the SW half of cluster #06 for plume reconnaissance, extending the HOMESIDE survey to the SE and the southern end of cluster #06. SOPHI was deployed at 21:44 and the track started at 22:41. The tow was adjusted to within the lowermost 200m to raise the chance for the detection of diffusive vents. The track ended after 20 km at 05:52 on November 30 and SOPHI was recovered at 07:06. No plumes were discovered. Subsequent station *INDEX2019-085CTD* identified the water masses in the license cluster #06 for the first time since the start of the prospecting/exploration activities. Start of the station at 08:23. 23/24 bottles sampled the different water masses from different water depths. The water masses survey reached the deepest point at 10:06 (3,686m) and ended at 11:22. It was followed by multinet station *INDEX2019-086MN* for first zooplankton sampling along the northernmost SEIR. The deployment started at 11:36 and sampling included all 9 nets. The station ended at 15:34. Station *INDEX2019-087WC* (location WC14) targeted a central axial volcanic cone just north of the northern rim of cluster #06. The wax corer was deployed at 16:14 and reached bottom at 17:18 (3,548m). Recovery was at 18:30 with no sample; all cups were empty. Station *INDEX2019-088WC* (location WC16) aimed at the sampling of a central axial volcanic cone near the center of the first segment of the SEIR. The wax corer was deployed at 19:33, reached bottom at 20:41 (3,581m) and was recovered at 21:45 with no sampling success. Station *INDEX2019-089HMS* targeted the eastern graben flank of cluster #06, in NW-SE direction. The tow covered the entire 40km length of the cluster and is situated at about SURYA equidistance to the northern SEIR graben axis. HOMESIDE was deployed at 23:53, started at 01:02 and finished the track at 06:31 on Sunday, December 01, with an early end due to harsh weather conditions. HOMESIDE was safely recovered at 07:27. The survey covered 11 km and identified flat volcanic terraces bounded by normal graben faults. No pillow volcanic domes or mounds were observed. A small redox and turbidity anomaly were recorded at approximately 2,780m depth. However, no anomalies are recorded in the maprs. Subsequent station *INDEX2019-090DR* sampled the western flank on the first off-axial ridge. The dredge was deployed at 11:57 and had bottom contact at 13:02 (3,678m). It left bottom at 15:03 (3,278m) and reached surface at 16:02, with ~400kg of aphyric pillow lava fragments and partly glassy lava flows. The next dredge (station *INDEX2019-091DR*) was also successfully deployed and sampled an axial volcanic cone in the center of the SEIR spreading ridge. The dredge was deployed at 16:53 and reached bottom at 18:03 (3,745m). Last bottom contact was at 19:33 (3,486m) and the dredge was brought to deck at 20:30. It successfully recovered ~250kg of very fresh and glassy phyric pillow basalts and laminar flows. Station *INDEX2019-092DR* sampled a young axial fault scarp structure in the center of the SEIR spreading ridge (SW flank). The dredge was deployed at 21:59 and reached bottom at 23:09 (3,904m). Dredging continued to December 02, the last bottom contact was registered at 3,746m at 00:52, and the dredge was recovered at 01:58 with ~75kg of pillow lava and glass, all very phyric with very large plagioclase and olivine crystals (megacrysts). After the last dredge, we transferred to cluster #07 (~35km).

The scheduled recovery of the sediment trap mooring in **cluster #07** (07-02) at 06:00 was abandoned due to sea and wind conditions. Instead, station *INDEX2019-093PS* was deployed for the first survey (11.5 km towpath) of the eastern graben wall, some 11-16km east of the active SEIR spreading center.

SOPHI was deployed at 07:36 and started the tow at 08:30. The track was finished after 11.4 km of towing at 13:09 and SOPHI was recovered at 13:23. No plumes could be discovered during this station neither with SOPHI nor with the maprs. Station *INDEX2019-094ST* recovered the sediment trap and current meter mooring 07-02. The station started at 16:00 and ended at 18:05. All 20 cups (18 days of sedimentation and subsequent rotation) are filled and three months show higher sedimentation rates than the others. The current meter also shows a complete data set for the one year. Station *INDEX2019-095HMS* explored the inner corner high on the eastern flank of cluster #07 along a 35km-long high-resolution swath bathymetry survey, in 2,5 lines, each ~12 km long. Start was at 18:51 and the track started at 19:53. It mapped sedimented basins on the northwestern slopes of the inner corner high with very steep flanks at NW and SE flanks and highly fractured pillow (?) domes on the SE flank. The inner corner high displays a generally rough terrain with slopes >40°. On the first line, there was clear evidence of redox and particle anomalies and a self-potential anomaly, as well as a recorded plume in an area of about 100x140m. A minimum of two vent sites were located plus a potential third one. There are also evidences for chimney-like edifices and perhaps gravel in a flat irregular-shaped mound. The field, named SOORAJ (Hindi for SONNE) is associated with a gentle slope that is cut by a steep slope to the East. This steep slope sheds talus material towards the sulfide field. There is no evidence from the bathymetric map to explain or to indicate the existence of this field. Similarities can be drawn to the KAIMANA field and its strongly fault-controlled occurrence of sulfide mineralization and chimneys, respectively. We continued station -095HMS to 11:29 on November 03. HOMESIDE was safely recovered at 12:25. Station *INDEX2019-096MN* studied the water column and distribution of zooplankton at the site of the sediment trap mooring 07-02. The station started at 13:14, reached the deepest point at 15:34 (3,900m) and sampled nine samples from 3,900-2,000 to 50-0m. Station *INDEX2019-097ST* deployed the sediment trap/current meter mooring 07-03 at the same site as the moorings before. Start at 18:25 and the anchor drop was at 19:44. The triangulation started at 20:15 and ended at 22:08. The mooring has a length of 570m and is located at 3,990m. The mooring 07-03 (570m) is positioned at 26°02.80'S/ 70°50.23'E, 3990m depth. After triangulation we transferred to cluster #10.

The first station on Wednesday, December 04, station *INDEX2019-098ST*, recovered the sediment trap and current meter mooring in **cluster #10** (10-02=. The station started at 06:47 and ended at 08:24 with the safe recovery of the sediment trap (17/20 cups filled), the current meter and two passive samplers. Station *INDEX2019-099MN* aimed at the study of zooplankton in cluster #10. The station started at 09:02 and reached the deepest point of 3,349m at 10:52. The multinet sampled nine different water depths from 3,200m to 0m and gained nine samples of zooplankton. The station finished with the recovery at 12:45. Station *INDEX2019-100ST* aimed at the deployment of mooring 10-03 (1xsediment trap, 1x current meter, 2 passive samplers; length of rope: 564m). The station started at 14:00 and the anchor was dropped at 15:33 (3,400m). The triangulation started at 16:25 and ended at 12:10. The mooring 10-03 (564m) is positioned at 26°53.60'S/ 72°20.43, 3,400m depth.

We continued our program and transferred to **cluster #12** (mooring station to mooring station: 99nm). On the arrival, we started the recovery of the mooring 12-02 on November 05. Station *INDEX2019-101ST* started with the release at 05:08 and the mooring (570m rope length) including the sediment trap and a current meter was safely recovered at 07:02 from a water depth of 3820m. 07/21 cups are filled. Station *INDEX2019-102ROPOS* aimed at a reconnaissance dive at the southern portion of the known HUNA vent site. The station started at 08:15 and ROPOS reached bottom at 10:03 (2,547m). Features identified in HOMESIDE tows were confirmed as strongly structured volcanic edifices. The HUNA sulfide locations from INDEX2018 were reconfirmed, with the identification of other (5th, 6th) occurrences in between the known mounds. All occurrences are small and hosted by volcanic talus beds. All vents show active diffuse and clear venting and are host to the characteristic biodiversity known from the other sites. The bottom was left at 17:58 (2,520m) and the dive ended with ROPOS recovery at 19:58. Subsequent station *INDEX2019-103HMS* aimed at the exploration and high-resolution bathymetry of the volcanic ridge ~1,200m W of HUNA towards the axial SEIR. The tow targeted a fault scarp along a 18.4 km long survey. HOMESIDE was deployed at 20:53 and the tow started at 21:25. The fault scarp is monotonous and displays a steep (30-38°) slope, mainly without significant structures or edifices. The top of the ridge terrace consists of highly structured and faulted pillow domes and linear volcanic features (dikes). The faults follow the general orientation of the graben axis. Near HUNA, the faults show bending and an association with larger volcanic edifices. There are no further indications for sulfide occurrences

or venting. The track ended at 05:27 on Friday, November 06 and HOMESIDE was recovered at 06:33. Station *INDEX2019-104ROPOS* addressed the northern part of HUNA and performed an intense fluid and faunal sampling. The dive started at 08:19 and ROPOS reached the seafloor at 09:07 (2,522m) at the HUNA main vent site from INDEX2018. Two more vent/sulfide sites were discovered, one inactive and strongly oxidized, the other representing a diffusive vent (Tmax=176°C). The HUNA field extends to the NW. The dive ended at 17:55 (2,534m) and ROPOS was recovered at 19:50. Station *INDEX2019-105HMS* targeted the central eastern flank of cluster #12. The station started at 20:32 and the tow at 21:52. The 19km of high-resolution bathymetry identified a monotonous fault scarp and slightly fractured terraces in the SE. HUNA was responsible for turbidity, redox and SP anomalies. Few pillow domes occur towards the NW of the line. Some of them may represent sets of sulfide edifices forming two groups of sharply bound edifices. We continued station -105HMS until 05:42 on December 07. HOMESIDE was safely recovered at 06:57. Station *INDEX2019-106ROPOS* addressed the northern part of HUNA area. The third dive studied the mound-shaped diffuse vents of strongly phase-separated fluids north of the 2018' HUNA field in greater detail and explored according to the mapping results from station -105HMS. The dive started at 08:20 and reached bottom at 10:07 (2,616m). A number of nine push cores were sampled in three profiles across a single hydrothermal mound. Fluid sampling of multiple diffuse and focused vents gave exit temperatures of 232°C and 296°C. A single anhydrite chimney was also sampled. Numerous diffuse vent areas and large-sized inactive sulfide mounds and edifices were identified along the dive path. The biodiversity was sampled and the first occurrence of annelida tube worms in the Indian Ocean was confirmed. Rock sampling of pillow and flow edifices resulted in glassy, aphyric basalts forming the host rocks of vent areas. The extension of HUNA was greatly enlarged to about 2.4 km length and about 300m width. HUNA is associated with a set of faults on the SW flank of the HUNA ridge, subparallel to PENUMBRA. Along this fault zone, numerous sulfide edifices and vents (diffuse) occur. The active vents are associated with (aphyric) basaltic talus and form fields only a few meters wide. It seems obvious that there may be sulfide mineralization below the talus. The inactive and strongly oxidized sulfide edifices are ~30m high, have flange-like appearances and extend for a couple of meters. The dive ended at 17:46 (2,545m) and ROPOS was recovered safely at 19:40. Station *INDEX2019-107HMS* addressed the area between the HUNA and PENUMBRA ridges to fill in high-resolution bathymetry gaps and have a very detailed PENUMBRA map. Wind and swell conditions did not allow the planned track and the detailed mapping at PENUMBRA had to be postponed. The station started at 20:29 and the track commenced at 21:28. 20km of high-resolution bathymetry was achieved in one line. A highly fractured and faulted volcanic ridge dominated the NW area and was followed by faulted pillow volcanoes. Sedimented terraces occur when approaching the PENUMBRA area. A volcanic dome was mapped on the lower terrace of the mineralized area. The line ended towards the SE in a sedimented area. Faulting could not be observed. The PENUMBRA area shows elevated turbidity but another indication for new sulfide sites were not achieved. The tow continued until 05:41 on Sunday, December 12 and HOMESIDE was recovered at 06:33. Following station *INDEX2019-108CTD* occurred at the position of the sediment trap mooring 12-02 for water masses survey. After some technical problems with the boom, the station started at 09:08 and reached the deepest point at 3,965m at 10:48. The CTD sampled 24 bottles from nine different depths. The station ended at 12:16. Subsequent station *INDEX2019-109PS* surveyed the NE' -most sulfide block of cluster #12 which is at 16.8 km E of the central spreading axis. The tow covered 10 km from NW to SE and started at 14:43 (deployment) and 15:40 (tow). The track ended at 19:52 and SOPHI was recovered at 20:51. SOPHI did not identify any plume in this section of cluster #12. Subsequent dredge station *INDEX2019-110DR* sampled a neovolcanic ridge from the western central SEIR spreading axis within the northern claim sulfide block. The station started at 22:40 and the dredge hit the bottom at 23:41 at 3,429m. Last bottom contact was at 01:01 (3,330m) on December 09, and the dredge was recovered at 02:08 with about 100kg of fresh glassy, mainly aphyric basalts. The next dredge station *INDEX2019-111DR* sampled a young elongated ridge in the axial SEIR graben and recovered one piece of glassy phyric basalt (~70kg). The station started at 02:43 and the dredge reached the bottom at 03:51 (3,445m). The last bottom contact was registered at 05:06 (3,244m) and the dredge was recovered at 06:13. The dredge station *INDEX2019-112DR* was deployed at the southern end of cluster #12 at the eastern flank of the deepest axial trough. The station started at 07:22 and the dredge reached bottom at 08:34 (3,903m). The last bottom contact occurred at 10:34 (3,738m) and the dredge was recovered at 11:37 with about 250kg of glassy pillow basalt fragments. For the following gravity corer stations we moved from the spreading axis area to the furthest eastern rim of license cluster #12. The area was sampled during INDEX2017 and high heat flow was registered in one single measurement. The station

INDEX2019-113GC (and the following stations) intended to sample and map the area of high heat flow to better constrain the origin. Longer gravity corers (7.5m) should provide better information from the potential occurrence of hydrothermal sediment at depth. The station addressed the area of the high heat flow and started at 13:19, hit the bottom at 14:33 (2,773m) and retrieved 2.64m (3.88m in 2017) of silty-clay sediment at 15:32. No indication for hydrothermal activity was found. Station *INDEX2019-114GC* sampled the same bathymetric low a few hundred meters to the SE. The station started at 15:50, reached the bottom at 16:49 (2,791m) and ended at 17:45. The corer retrieved 2.68m of the same sediment material without any indication for hydrothermal overprint. Station *INDEX2019-115GC* sampled an area closer to and in between central and small bathymetric highs (~50m distance) resembling sedimented pillow volcanoes. The station started at 17:57 and the corer reached the bottom at 18:56 (2,841m). After corer recovery at 19:56, 2.56cm of sediment was sampled. The core catcher contained ubiquitous glass shards and fragments from the nearby volcanic edifices. No indication for hydrothermal sediment or activity was found. Station *INDEX2019-116HF* studied the heat flow in the bathymetric low along the eastern rim of cluster #12. The station started at 21:31 and the heat flow probe reached seafloor at 22:39 (2,768m). The last bottom contact was at 23:02 (2,768m) and the heat flow probe moved on 100m above bottom to the next station. One temperature gradient was measured and the subsequent heating experiment was carried out with all sensors penetrating the sediment. The estimated heat flow density is at 107.3mW/m² and a thermal conductivity of 0.94W/m°C, and at the expected regional level. We continued the series of heat flow measurements along the eastern cluster border on December 10 with station *INDEX2019-117HF* in the wider area (~50-70m) of the high heat flow determined during INDEX2017 (station INDEX2017-77HF) about 0.4nm SE of station -116HF. The station started at 00:30 and the probe reached bottom at 00:42 (2,789m). All sensors penetrated the sediment and one temperature gradient was measured, the heating experiment was conducted. The heat flow is distinctly higher at 221.4mW/m² and a thermal conductivity of 1.08W/m°C. The probe was lifted at 01:04 (2,790m) and transferred at 100m elevation to the next station *INDEX2019-118HF*, about 0.2nm SSE of -117HF and to the position of gravity corer station -114GC. The station started at 01:48 and the probe reached bottom again at 01:57 (2,793m). All sensors penetrated the sediment, the temperature gradient was measured, the heating experiment conducted. The estimated heat flow was again lower, at 190.1 mW/m², and a conductivity of 1.08W/m°C. The probe was lifted at 02:21 (2,796m) and transferred to the next station *INDEX2019-119HF*. This heat flow station is the same as station -115GC and is situated in between two mound-shaped edifices some 0.3nm SE of station -118HF, identified as pillow volcanoes as shown from glass in the core catcher of the gravity corer (-115GC). The start was at 03:18 and the heat flow probe landed on the bottom at 03:28 (2,844m). All sensors penetrated again the sediment, two temperature gradients were measured and one heating experiment conducted. The estimated heat flow was again lower, at 127.1mW/m², with thermal conductivity of 1.12W/m°C. The probe was lifted from the bottom at 04:10 and transferred to station *INDEX2019-120HF*. This station is 0.3nm SE of station -119HF, covers the area in between sedimented pillow volcanoes and started at 05:06, with the first bottom contact at 05:16 (2,863m). The probe had 6/7 sensors in the sediment and performed two temperature gradient measurements and one heating experiment. The estimated heat flow was again higher, at 232.2mW/m², with a conductivity of 1.12W/m°C. The probe was lifted at 05:59 (2,864m) and brought safely back to surface at 07:00. Subsequent station *INDEX2019-121ST* redeployed the sediment trap and current meter mooring 12-03 in cluster #12. The station started at 08:53 and the anchor was dropped at 09:51. Triangulation was started at 10:40 and ended at 11:46. Mooring 12-03 (570m) is located at position 27°48.22'S / 73°53.39'E, 3,920m. Station *INDEX2019-122MN* surveyed and sampled the zooplankton distribution close to mooring 12-03. The station started at 11:56 and reached the deepest point at 14:00. The station ended at 15:58 and sampled zooplankton from nine depth intervals. Stations *INDEX2019-123GC* and *INDEX2019-124GC* aimed at the sampling of hydrothermal sediment from the newly identified silica hill in the NW elongation of the HUNA area. The hill was successfully sampled by ROPOS push cores and the gravity corer (2.5m) aimed at a greater depth extension. Station -123GC started at 17:18, reached bottom at 18:14 (2,643m) and was recovered at 19:09, with 155cm of silica-dominated hydrothermal sediment. Station -124GC started at 19:20, reached bottom at 20:15 (2,642m) and was recovered at 21:08, with 144cm of whitish-greyish hydrothermal sediment with a distinct H2S smell and a characteristic hydrothermal fauna (Bathymodyolus, Barnacles) on top. Subsequent heat flow station *INDEX2019-125HF* addressed the same mound. The station started at 22:55 and reached bottom at 23:55 (2,642m). 6/7 sensors penetrated the sediment and reached the temperature limit of 50°C immediately. When pulled out, the temperatures dropped rapidly to seawater temperatures. Thermistors

and electronics were not damaged. The probe left bottom at 00:02 (2,642m) and was recovered at 01:01 on Wednesday, December 11. Station *INDEX2019-126HMS* continued with a detailed high-resolution bathymetry survey over the PENUMBRA area. The station started at 02:00 and the track commenced at 02:45. Approximately 2 km of the track were achieved and five active/inactive mounds were imaged at detail. All sensors were working well picking up distinct anomalies. HOMESIDE ended the track at 05:05 and was recovered at 05:48. Subsequent to this station a block of concrete (1.5 t) plus a float was moored on the seafloor close to PENUMBRA mound no. 12 for material studies. The block will be surveyed over time and the status of weathering will be documented. Station *INDEX2019-127ROPOS* surveyed the deeper slope areas of the PENUMBRA area, to the SW of the known sulfide area along the slope of the identified edifices. ROPOS was deployed at 08:40 and reached bottom at 10:27 (2,531m). The dive identified downslope extensions of PENUMBRA with new low temperature diffusive and focused black smoker-type venting. Four samples of vent fluids were obtained. Sulfide and rock samples were recovered. ROPOS left bottom at 17:27 (2,351m) and was safely recovered at 19:45. Station *INDEX2019-128HMS* mapped about 18.8 km of high-resolution bathymetry in two subparallel lines on the western graben flank in the area of potential sources for native gold on fresh volcanic rocks (INDEX2017-70DR). Deployment started at 21:20 and the tow commenced at 22:21. The area is highly tectonized with fractured pillow domes and volcanic ridges. There was, however, no evidence for sulfide occurrences or hydrothermal activity. The station continued to December 12 to 06:27 and HOMESIDE was recovered at 07:26. Station *INDEX2019-129ROPOS* surveyed the volcanic edifice with native gold (station INDEX2017-70DR) and neighboring volcanic ridges and edifices. ROPOS was deployed at 08:36 and reached seafloor at 10:43 (2,781m). The dive identified steep tectonized ridges of pillow basalt flows with nicely developed pillow tubes. The volcanic edifice is indeed a young and poorly sedimented pillow volcanoe with several volcanic vents on top and on the SW flank. No indication for hydrothermal activity, alteration, exhumed deeper crust or inactive sites was identified. Volcanic rocks, all fresh and partly glassy were sampled as well as sediments by push cores. It is obvious that even fresh volcanic rocks and glass are covered by thicker Mn crusts potentially indicating hydrothermal plume fallout in the area. The site, however, is not identified yet. The dive ended at 15:55 (3,236m) and ROPOS was recovered at 19:11. Station *INDEX2019-130HMS* covered the western graben flank to continue the mapping of the one western sulfide block in the vicinity of the Au-bearing volcanic edifice on the western graben flank. The station started at 19:44 and the tow track at 20:42. The tow was 15km long and included one turn. It mapped strongly structured pillow volcanoes without any evidence for sulfide fields or hydrothermal venting. The HOMESIDE tow continued to 05:00 on Friday, December 13, and the sled was recovered at 06:05. The station *INDEX2019-131PS* addressed the western graben flank at about 7.5 km west of the spreading graben axis, along a 10km-long tow track. The station started with the deployment of SOPHI at 06:48. The tow track started at 07:38 and ended at 11:54. SOPHI was safely recovered at 13:08 without localization of any new vent site. The findings of native gold on a fresh pillow volcano edifice back in 2017 and the suggestion of its origin from phase separated fluids comparable to the HUNA and PENUMBRA fluids on the eastern graben flank remain unclear. More exploration work is necessary during the next INDEX cruises.

We finished the program during SO271/1 (INDEX2019) with the station -131PS and left for Port Louis at 13:30 and the transit for 1100nm. Lab and equipment demobilization started immediately after the last station. The chief scientist presented a talk for the SONNE crew of at 20:00. The lab and equipment demobilization continued on Saturday, December 14 (clock set back to UTC +4 hrs.) and Sunday 15 when SONNE also entered Mauritian waters at 14:00, and ended the bathymetric and water column surveys. Lab and equipment demobilization where finished as far as possible while at sea late on Monday, December 16 and the cruise ended with the arrival at the Port Louis pilot station at 05:30. SONNE docked on the Quay D (QD) at 06:30, Tuesday, December 17. Demobilization of ROPOS and BGR equipment continued and the containers were offloaded the same day and December 18. The scientific party of cruise SO271 (INDEX2019), Leg 1, departed SONNE for the airport or the hotels on December 18 morning and afternoon. The scientific crew for Leg 2 boarded SONNE the same day and started the preparations and mobilization for the cruise. Participants of Leg 1 returned to Germany individually or in groups in the following days.

Table 1. Timing and station plan during cruise SO271/1 (INDEX 2019).

Date	**Activities**	**Position**		**Working days/at sea**
Sun 27.10.2019	Departure			1
Mon 28.10.2019	Arrival Port Louis/Mauritius			2
Tue 29.10.2019	Port Louis, Start Mobilization on TFS SONNE			3
Wed 30.10.2019	Port Louis, Mobilization			4
Thu 31.10.2019	Port Louis, Mobilization and Scientific Crew Embarkation			5
Fri 01.11.2019	Port Louis, Mobilization and Departure **Transit**			6/1
Sat 02.11.2019	**Transit**			7/2
Sun 03.11.2019	**Transit**			8/3
Mon 04.11.2019	**Transit**			9/4
	Cluster #1/1	21°14.88'S	68°35.15'E	
	INDEX2019-001CTD	21°14.88'S	68°35.15'E	
	INDEX2019-002MN	21°14.88'S	68°35.15'E	
	INDEX2019-003MUC	21°14.88'S	68°35.15'E	
	INDEX2019-004PS	21°13.185'S	68°34.586'E	
Tue 05.11.2019	**Cluster #1/2**			10/5
	INDEX2019-005ST	21°14.88'S	68°35.15'E	
	INDEX2019-006ROPOS	21°14.88'S	68°35.15'E	
	INDEX2019-007HMS	21°28.599'S	68°40.703'E	
Wed 06.11.2019	**Cluster #1/3**			11/6
	INDEX2019-008WC	21°11.763'S	68°38.758'E	
	INDEX2019-009WC	21°12.529'S	68°39.627'E	
	INDEX2019-010WC	21°13.566'S	68°41.114'E	
	INDEX2019-011ROPOS	21°28.429'S	68°40.542'E	
	INDEX2019-012PS	21°22.088'S	68°53.422'E	
Thu 07.11.2019	**Cluster #1/4**			12/7
	INDEX2019-013ST	21°14.88'S	68°35.15'E	
	INDEX2019-014HMS	21°23.229'S	68°51.267'E	
Fri 08.11.2019	**Cluster #4/1**			13/8
	INDEX2019-015WC	23°48.009'S	69°30.558'E	
	INDEX2019-016WC	23°49.294'S	69°29.220'E	
Sat 09.11.2019	**Cluster #4/2**			14/9
	INDEX2019-017WC	23°50.411'S	69°31.189'E	
	INDEX2019-018WC	23°52.089'S	69°33.046'E	
	INDEX2019-019WC	23°52.210'S	69°31.358'E	
	INDEX2019-020CTD	23°52.210'S	69°31.358'E	
	INDEX2019-021MN	23°52.210'S	69°31.358'E	
	INDEX2019-022WC	23°53.407'S	69°34.201'E	
	INDEX2019-023WC	23°57.457'S	69°34.169'E	
	INDEX2019-024WC	23°58.744'S	69°32.658'E	

Table 1.1. (continued) Timing and station plan during cruise SO271/1 (INDEX 2019).

Sun 10.11.2019	**Cluster #4/3**			15/10
	INDEX2019-025WC	23°58.953’S	69°34.070’E	
	INDEX2019-026ST	23°51.98’S	69°29.48’E	
	INDEX2019-027ROPOS	23°52.680`S	69°35.812’E	
	INDEX2019-028HMS	23°52.500’S	69°36.100’E	
Mon 11.11.2019	**Cluster #4/4**			16/11
	INDEX2019-029MUC	23°51.3098’S	69°33.3427’E	
	INDEX2019-030MUC	23°51.3098’S	69°33.3427’E	
	INDEX2019-031ROPOS	23°53.424’S	69°36.784’E	
	INDEX2019-032HMS	23°47.6718’S	69°33.7944’E	
Tue 12.11.2019	**Cluster #4/5**			17/12
	INDEX2019-033ROPOS	23°52.060’S	69°36.386’E	
	INDEX2019-034HMS	23°46.3908’S	69°31.5948’E	
Wed 13.11.2019	**Cluster #4/6**			18/13
	INDEX2019-035ST	23°51.98’S	69°29.48’E	
Thu 14.11.2019	**Cluster #5/1**			19/14
	INDEX2019-036ROPOS	25°27.962’S	69°55.560’E	
	INDEX2019-037HMS	25°31.987’S	69°56.776’E	
Fri 15.11.2019	**Cluster #5/2**			20/15
	INDEX2019-038WC	25°25.277'S	70°00.577'E	
	INDEX2019-039WC	25°28.771'S	70°02.695'E	
	INDEX2019-040ROPOS	25°27.875’S	69°56.213’E	
	INDEX2019-041HMS	25°31.988’S	69°57.128’E	
Sat 16.11.2019	**Cluster #5/3**			21/16
	INDEX2019-042ROPOS	25°27.904’S	69°56.159’E	
	INDEX2019-043PS	25°26.072’S	69°58.511’E	
Sun 17.11.2019	**Cluster #5/4**			22/17
	INDEX2019-044DR	25°50.103’S	69°26.606’E	
	INDEX2019-045DR	25°41.670’S	69°32.282’E	
Mon 18.11.2019	**Cluster #5/5**			23/18
	INDEX2019-046DR	25°45.419’S	69°38.037’E	
	INDEX2019-047PS	25°39.984’S	69°44.940’E	
	INDEX2019-048CTD	25°39.984’S	69°44.940’E	
	INDEX2019-049CTD	25°39.984’S	69°44.940’E	
	INDEX2019-050MN	25°39.984’S	69°44.940’E	
	INDEX2019-051DR	25°37.285’S	69°51.853’E	
Tue 19.11.2019	**Cluster #5/6**			24/19
	INDEX2019-052DR	25°35.118’S	69°51.291’E	
	INDEX2019-053DR	25°39.075’S	69°52.675’E	
	INDEX2019-054PS	25°30.734’S	69°58.561’E	
Wed 20.11.2019	**Cluster #5/7**			25/20
	INDEX2019-055HMS	25°27.816’S	69°54.966’E	
	INDEX2019-056ROPOS	25°28.195’S	69°54.664’E	
	INDEX2019-057HMS	25°27.063’S	69°50.240’E	
Thu 21.11.2019	**Cluster #5/8**			26/21
	INDEX2019-058ROPOS	25°24.255’S	69°46.337’E	
	INDEX2019-059WC	25°25.897’S	69°44.136’E	
	INDEX2019-060WC	25°29.520’S	69°46.320’E	

Table 1.1. (continued) Timing and station plan during cruise SO271/1 (INDEX 2019).

Fri 22.11.2019	**Cluster #5/9**			27/22
	INDEX2019-061GC	25°24.936’S	69°42.990’E	
	INDEX2019-062HF	25°24.936’S	69°42.990’E	
	INDEX2019-063WC	25°30.379’S	69°49.736’E	
	INDEX2019-064DR	25°36.047’S	69°54.459’E	
	INDEX2019-065DR	25°34.226’S	70°00.412’E	
Sat 23.11.2019	**Cluster #5/10**			28/23
	INDEX2019-066WC	25°31.700’S	70°03.254’E	
	INDEX2019-067WC	25°27.163’S	70°01.760’E	
	INDEX2019-068ADCP	25°19.30’S	70°02.30’E	
	INDEX2019-069PS	25°26.956’S	70°10.117’E	
Sun 24.11.2019	**Cluster #5/11**			29/24
	INDEX2019-070HMS	25°27.095’S	70°09.459’E	
Mon 25.11.2019	**Cluster #5/12**			30/25
	INDEX2019-071ROPOS	25°24.162’S	70°06.399’E	
	INDEX2019-072HMS	25°20.564’S	70°02.669’E	
Tue 26.11.2019	**Cluster #5/13**			31/26
	INDEX2019-073ROPOS	25°19.406’S	70°02.495’E	
	INDEX2019-074PS	25°17.204’S	70°15.378’E	
Wed 27.11.2019	**Cluster #5/14**			32/27
	INDEX2019-075ADCP	25°19.30’S	70°02.30’E	
	INDEX2019-076GC	25°24.935’S	70°14.110’E	
	INDEX2019-077HF	25°24.935’S	70°14.110’E	
Thu 28.11.2019	**Cluster #6/1**			33/28
	INDEX2019-078WC	25°30.281’S	70°02.398’E	
	INDEX2019-079WC	25°32.610’S	70°03.542’E	
	INDEX2019-080WC	25°36.975’S	70°01.364’E	
	INDEX2019-081PS	25°49.925'S	70°11.159'E	
	INDEX2019-082HMS	25°52.987'S	70°10.878'E	
Fri 29.11.2019	**Cluster #6/2**			34/29
	INDEX2019-083ROPOS	25°49.546’S	70°07.495’E	
	INDEX2019-084PS	26°01.035’S	70°18.847’E	
Sat 30.11.2019	**Cluster #6/3**			35/30
	INDEX2019-085CTD	25°42.315’S	70°07.190’E	
	INDEX2019-086MN	25°42.315’S	70°07.190’E	
	INDEX2019-087WC	25°42.002’S	70°06.317’E	
	INDEX2019-088WC	25°47.718’S	70°10.850’E	
	INDEX2019-089HMS	25°56.127’S	70°25.589’E	
Sun 01.12.2019	**Cluster #6/4**			36/31
	INDEX2019-090DR	25°44.467’S	70°07.973’E	
	INDEX2019-091DR	25°47.462’S	70°11.640’E	
	INDEX2019-092DR	25°52.795’S	70°16.342’E	
Mon 02.12.2019	**Cluster #7/1**			37/32
	INDEX2019-093PS	26°04.079’S	71°00.217’E	
	INDEX2019-094ST	26°02.68’S	70°50.60’E	
	INDEX2019-095HMS	26°05.010’S	70°52.310’E	
Tue 03.12.2019	**Cluster #7/2**			38/33
	INDEX2019-096MN	26°02.68’S	70°50.60’E	
	INDEX2019-097ST	26°02.68’S	70°50.60’E	

Table 1.1. (continued) Timing and station plan during cruise SO271/1 (INDEX 2019).

Wed 04.12.2019	**Cluster #10/1**			39/34
	INDEX2019-098ST	26°53.95'S	72°20.48'E	
	INDEX2019-099MN	26°53.72'S	72°20.37'E	
	INDEX2019-100ST	26°53.72'S	72°20.37'E	
Thu 05.12.2019	**Cluster #12/1**			40/35
	INDEX2019-101ST	27°48.23’S	73°53.33’E	
	INDEX2019-102ROPOS	27.64548S	73.87067E	
	INDEX2019-103HMS	27°38.177’S	73°50.542’E	
Fri 06.12.2019	**Cluster #12/2**			41/36
	INDEX2019-104ROPOS	27°38.322’S	73°51.609’E	
	INDEX2019-105HMS	27°41.077’S	73°54.608’E	
Sat 07.12.2019	**Cluster #12/3**			42/37
	INDEX2019-106ROPOS	27°38.000’S	73°51.008’E	
	INDEX2019-107HMS	27°38.904’S	73°53.742’E	
Sun 08.12.2019	**Cluster #12/4**			43/38
	INDEX2019-108CTD	27°48.23’S	73°53.33’E	
	INDEX2019-109PS	27°35.588’S	73°52.661’E	
	INDEX2019-110DR	27°39.606’S	73°41.880’E	
Mon 09.12.2019	**Cluster #12/5**			44/39
	INDEX2019-111DR	27°40.763’S	73°44.244’E	
	INDEX2019-112DR	27°47.541’S	73°52.128’E	
	INDEX2019-113GC	27°37.432’S	73°55.945’E	
	INDEX2019-114GC	27°37.593’S	73°56.252’E	
	INDEX2019-115GC	27°37.738’S	73°56.605’E	
	INDEX2019-116HF	27°37.214’S	73°55.709’E	
Tue 10.12.2019	**Cluster #12/6**			45/40
	INDEX2019-117HF	27°37.414’S	73°56.156’E	
	INDEX2019-118HF	27°37.592’S	73°56.252’E	
	INDEX2019-119HF	27°37.736’S	73°56.607’E	
	INDEX2019-120HF	27°37.925’S	73°56.887’E	
	INDEX2019-121ST	27°48.23’S	73°53.33’E	
	INDEX2019-122MN	27°48.23’S	73°53.33’E	
	INDEX2019-123GC	27°38.000’S	73°51.008’E	
	INDEX2019-124GC	27°38.000’S	73°51.008’E	
	INDEX2019-125HF	27°38.000’S	73°51.008’E	
Wed 11.12.2019	**Cluster #12/7**			46/41
	INDEX2019-126HMS	27°37.654’S	73°51.846’E	
	INDEX2019-127ROPOS	27°37.960’S	73°52.103’E	
	INDEX2019-128HMS	27°43.518	73°42.093	
Thu 12.12.2019	**Cluster #12/8**			47/42
	INDEX2019-129ROPOS	27°39.326’S	73°39.584’E	
	INDEX2019-130HMS	27°38.926’S	73°38.784’E	
Fri 13.12.2019	**Cluster #12/9**			48/43
	INDEX2019-131PS	27°43.857’S	73°41.615’E	
	Transit			
Sat 14.12.2019	**Transit**			49/44
Sun 15.12.2019	**Transit**			50/45
Mon 16.12.2019	**Transit**			51/46
Tue 17.12.2019	**Transit**			52/47
	Arrival Port Louis			

Table 1.1. (continued) Timing and station plan during cruise SO271/1 (INDEX 2019).

Wed 18.12.2019	Port Louis, Demobilization		53
Thu 19.12.2019	Port Louis, Departure of Scientific Crew Departure for Leg SO271/2		54

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Participants

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3. Sebastian Fuchs	Sulfide Petrology	BGR
4. Ingo Heyde	Magnetics, Heat Flow	BGR
5. Conny Kriete	Sensor Sled	BGR
6. Gary Massoth	Sensor Sled	Mass-Ex[3]
7. Andreas Lückge	Paleooceanography	BGR
8. Niko Lahajnar	Moorings	Uni Hamburg
9. Natalie Harms	Moorings	Uni Hamburg
10. Willi Weinrebe	Bathymetry, WCI	Wein_Kiel
11. Christian Wöhrl	Technician, Analyses	BGR
12. Henning Wedemeier	Elektronics HOMESIDE	BGR
13. Joachim Deppe	Elektronics Magnetics, HF	BGR
14. Oliver Kefel	Mechanics	BGR
15. Stephan Deike	Sample Preparation	BGR
16. Andreas Heiner	Sample Preparation	BGR
17. Simone Sturm	Logistics, Sampling	BGR
18. Terue Kihara	Biodiversity	DZMB
19. Klaas Gerdes	Biodiversity	DZMB
20. Katharina Kniesz	Biodiversity	DZMB
21. Bastienne Schöning	Biodiversity	DZMB
22. Tanja Dufek	Hydrography	HCU Hamburg
23. Dilip Adhikari	Hydrography	HCU Hamburg
24. Dieter Garbe-Schönberg	Fluid Sampling	Uni Kiel
25. René Romer	Petrology	Uni Erlangen
26. Christine Meyzen	Petrology	Uni Erlangen
27. Harold Gibson	Sulfide Area Mapping	Laurentian U.

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28. Marina Schofield	Sulfide Area Mapping	Laurentian U.
29. Sebastian Graber	Site Bathymetry	GEOMAR
30. Katja Laufer	Microbiology	GEOMAR
31. Bettina Landsmann	Public Relations	BGR
32. Ragnar Seifert	Mechanics	BGR
33. Anke Spethmann	Moorings	Uni Hamburg
34 Keith Tamburri	Pilot	ROPOS
35. Paul Macoun	Pilot	ROPOS
36. Luke Girard	Pilot	ROPOS
37. Peter Lockhart	Pilot	ROPOS
38. Barry Brake	Pilot	ROPOS
39. Jonathan Lee	Pilot	ROPOS

Abb. 1. Die Fahrtteilnehmer der Ausfahrt SO271/1 (INDEX2019) (obere Reihe, von links nach rechts): Ulrich Schwarz-Schampera (BGR), Willi Weinrebe (Kiel), Niko Lahajnar (U. Hamburg), Simone Sturm (BGR), René Romer (U. Erlangen), Sebastian Graber (GEOMAR), Terue Kihara (DZMB-INES), Tanja Dufek (HCU Hamburg), Ragnar Fröhlich (BGR), Stephan Deike (BGR), Dieter Garbe-Schönberg (CAU Kiel), Andreas Lückge, Ralf Freitag, Sebastian Fuchs, Henning Wedemeyer (alle BGR), Harold L. Gibson (Laurentian U. Canada), Jonathan Lee, Keith Tamburri, Peter Lockhart (alle ROPOS). (mittlere Reihe, von links nach rechts) Christian Wöhrl (BGR), Ingo Heyde (BGR), Klaas Gerdes (DZMB-INES), Natalie Harms (U. Hamburg), Katja Laufer (GEOMAR), Joachim Deppe (BGR), Luke Girard (ROPOS), Barry Brake ROPOS). (untere Reihe, von links nach rechts) Bastienne Schöning (DZMB), Bettina Landsmann (BGR), Marine Schofield (Laurentian U. Canada), Katharina Kniesz (DZMB), Gary Massoth (USA), Christine Meyzen (U. Padua Italy), Conny Kriete (BGR), Andreas Heiner (BGR), Dilip Adhikari (HCU Hamburg), Oliver Kefel (BGR), Anke Spethmann (U. Hamburg), Paul Macoun (ROPOS).

Fig. 1.1. The participants of cruise SO271/1 (INDEX2019) (upper and lower row, from left to right).