Sentry Operations Report for the 2014 Kinsey and Farr & Tivey Cruise

WHOI Sentry Operations Group
Dr. James Kinsey, Zac Berkowitz, Alan Duester, Justin Fujii, Johanna Hansen, Meme Lobecker (Leg B)

Sentry Expedition Leader: Dr. James Kinsey

Sentry PIs: Optical Modem:Norm Farr (WHOI), and Dr. Maurice Tivey (WHOI);
Heat Flux: Dr. James Kinsey (WHOI), Dr. Tim Crone (Lamont-Doherty Earth Observatory), and Professor Eric Mittelstadt (University of Idaho)
Cruise Chief Scientist: Dr. Tim Crone, Lamont-Doherty Earth Observatory

R/V Atlantis — July 13, 2014 to August 7, 2014

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1 Summary

This document summarizes operations with the *Sentry* autonomous underwater vehicle (AUV) during a July 2014 aboard the R/V Atlantis. This was a 4 project, 8 PI cruise in which *Sentry* operated in tandem with Alvin and supported two projects. The first project, under the supervision of Farr and Tivey, was the testing of optical modems on *Sentry* including using *Sentry* to autonomously offload data. The second project, lead by Kinsey, Mittelstadt, and Crone, sought to quantify heat flux at the ASHES and Main Endeavor hydrothermal vents. This report includes the vehicle configuration; basic vehicle and sensor performance; and post-dive reports (with summary statistics and narratives). This report does not attempt to describe the scientific results or conclusions. A detailed description of the data files resulting from this cruise is provided in a separate document.

2 Cruise Log

This section provides a brief chronological summary of *Sentry* activities during the cruise. Additional information on specific dives is available in the dive reports.

July 11 — First day of the mobilization. The green (server/workshop) van was placed on the aft deck, the blue van on the 01 Deck. Cables run and lab infrastructure installed. Andrew Billings and Kevin Kavanaugh joined us for the mob. Jboxes were opened, bad cables for Kinsey gear replaced, and gear tested. Decktest run and most major components running. Mechanical install of new stinger pole.

July 12 — Continued setup throughout the day with a focus on testing the optical modems. Cliff Pontibrand from the WHOI optical modem group supported this integration. Additional work continued in parallel — Andy Billings serviced the drop motors and sensor configuration for the heat flux package continued.

July 13 — Completed OComms testing and began conversion to the heat flux sensing package. Troubleshooting of the 300kHz DVL because of intermittent comms. A faulty whip was replaced. The Cliff and Jo worked on the optical modem gear and achieved their goals for the mob. Their hardwork late into Saturday night paid off. Special thanks to Jo for leading this effort. All of the gear for the first leg science program is installed and working.

July 14 — Sailed from Astoria at 0800 local and transited out to Axial Seamount.

July 15 — On station at Axial seamount. Alvin dove during the day for a recon dive including determining the location of various vents and hazards at Ashes. USBL performed well with 10m watch circles. The ship did a spin while Alvin sat on the seafloor and the watch circle did not change significantly. We plan to place a USBL beacon on the seafloor on the next Alvin dive to help assess any errors.

The wind picked up through the afternoon (20-25kts, gusting to 30) so the decision was made to scrub tonight's dive especially in light of the science gear protruding from the front of the vehicle. Winds should diminish tomorrow in the mid to late morning and we'll plan to dive tomorrow night or earlier if weather affects the Alvin dive.

July 16 — Weather continued to preclude operations.

July 17 — Launched Sentry 271. Recovered 3.5 hours later because of technical failures. See dive report for more info.

July 18 — Launched Sentry 272. See dive report for more info.

July 19 — Recovered Sentry 272 in the morning. Launched Sentry 273 that evening. See dive report for more info.

July 20 — Recovered Sentry 273 in the morning. Launched Sentry 274 that evening. See dive report for more info.

July 21 — Recovered Sentry 274 in the morning. Launched Sentry 275 that evening. See dive report for more info.

July 22 — Recovered Sentry 275 in the morning. Weather precluded launching that evening.

July 23 — Continued poor weather all day. Considered late evening launch but weather prevented.

July 24 — Launched Sentry 276 at MEF. See dive report for more info.

July 25 — Recovered Sentry 276. Began transit to Astoria at the completion of the Alvin dive. Began conversion from heat flux sensing suite to optical modem.

July 26 — Arrived in Astoria mid-afternoon for mid-cruise port stop.

July 27 — Departed Astoria at 1600 for 1025C cork site.

July 28 — Arrived at 1025C site in late afternoon. Launched Sentry 277 that evening. See dive report for more info.

July 29 — Recovered Sentry 277 in the morning. Transited to 825D after recovering Alvin.

July 30 — Launched Sentry 278 that evening. See dive report for more info.

July 31 — Recovered Sentry 278 in the morning. Because of weather concerns, transited to ASHES.

Aug 1 — Launched Sentry 279 late that evening. DVL failure and subsequent crash into seafloor required mission abort. See dive report for more info.

Aug 2 — Conversion to heat flux sensing suite and repairs from Sentry 279.

Aug 3 — Launched Sentry 280 in the early morning. Acoustic modem failure required an early abort. After making repairs, launched Sentry 281 in the afternoon. See dive report for more info.

Aug 4 — Sentry 281 continued throughout the day.

Aug 5 — Recovered Sentry 281 in the morning. Began transit to Astoria.

Aug 6 — Demob in Astoria, OR.

Aug 7 — Offloaded vans.

3 Vehicle Configuration

The two science programs on this cruise (heat flux and optical communications) used different vehicle configurations on this cruise. Vehicle configurations were dive specific and are listed in the individual dive reports.

3.1 Optical Communication System (OCS)

The Optical Communication System (OCS) consists of a master and slave system that each contain an optical transmitter and receiver and an Avtrak6. The master system mounted to the underside of Sentry and was assigned an IP address in Sentry's local subnet. The slave system was mounted to a lander that was deployed independently to the seafloor. The location of the lander was monitored from the topside using an Avtrak2. Shift commands are used once Sentry reaches bottom-lock to center its mission over the lander.

The master system relayed messages either acoustically or optically to the slave and reported optical status and acoustically determined range at predetermined intervals. The Optical Command Driver (OCD)

runs on Sentry's Datapod computer to interpret commands comming from Sentry's control system, topside USBL SMS, and the Optical System. It also computes the location of the slave OCS based on acoustic and optical data and is able to suggest shift commands that will improve positioning of Sentry in relation to the slave.

4 Navigation

All dives were navigated using realtime Doppler Velocity Log (DVL) velocity inertial measurement unit (IMU) attitude measurements. External aiding during descent was performed with Ultra-Short Baseline (USBL) throughout the cruise. Dive specific notes on navigation are included in the dive reports. All final navigation consists of a track where the DVL/IMU track was fused with the USBL fixes in post-processing.

4.1 Coordinate origins

The vehicle's control system uses simple equidistant coordinates. This system uses an origin, defined in terms of latitude and longitude with the World Geodetic System 1984 (WGS84) datum, and a fixed scaling between meters displacement from the origin. We use the identical routines that have been used by the National Deep Submergence Facility (NDSF) assets Alvin and Jason for decades. Likewise we always used the same origin for Sentry and Alvin at each site. These simple coordinates have several advantages for realtime control of a vehicle. Unlike Universal Transverse Mercator (UTM) grid coordinates, the x and y axes intersect at right angles and align with true east and north respectively at the origin. These coordinates distort quickly as one moves away from the origin, but we solve that problem by putting the origin close to the operating area. We almost always report our results in latitude/longitude, so most users need not be aware of these details.

The origin changed throughout the cruise. Table ??? lists the origins for each dive.

4.2 USBL Calibration and Performance Notes

We used a CASIUS calibration previously done on Atlantis. The offsets obtained during this calibration were used for all Sentry dives. USBL problems occurred throughout the cruise — they are reviewed in more detail in the technical issues section.

5 Technical Issues

This section summarizes technical issues encountered by the *Sentry* operations group on the cruise. Issues which affected primarily individual dives are listed in the individual dive reports.

T.1: Bottom following software — Sentry 271 was aborted because of issues with the bottom follower. These issues are discussed in the dive report. The third cause, a conditional that determines if the vehicle goes into ROV mode, needs to be reviewed. Specifically, we need to decide if the code change made on the cruise should be permanent. See the dive report for Sentry 271 for more discussion.

T.2: Atlantis USBL — USBL tracking was problematic throughout the cruise both with *Sentry* and with other over the side gear. The issues can be broken down as follows:

1. *GPS offsets were not properly compensated for in the topside-navest code.* Throughout this cruise (and on earlier cruises) the position of *Sentry* appeared to randomly move on the order of 10-40 meters. On this cruise, we saw a strong correlation between USBL performance and ship's heading, suggesting an issue with GPS offsets. On the last dive we determined that this was the result of the GPS to reference position offset not being computed. A hack fix was made and tested to verify that this bug; however this hack should be replaced with a cleaner piece of code. Subsequent conversations with Jon Howland indicated that GPS offsets had been implemented but there might be a bug. **This bug needs to be investigated and fixed.**
2. *Ambiguity over the proper offsets.* Once the hack was implemented, the translational offsets in the navest ini file were still wrong. *Sentry* team has been assuming using the translational offset from the GPS antenna to the USBL ducer when in fact we should be using the translational offset from the GPS antenna to the Central Reference Position (CRP). **The exact conventions need to be clearly defined for the Ops team. We should consider writing a worksheet where the math is worked out for each new ship and that worksheet is kept as a reference for future installations.**
3. *We frequently had no USBL during descent.* This issue plagued us throughout the cruise. On multiple descents, USBL tracking was not present during descent. USBL tracking would resume toward the end of the descent though this observation is casual. A deterministic solution was not found to this problem — restarting the system, pressing the "not set" button for the beacon, and the transreceiver reset were all tried. Sometimes these solutions would work but often only after multiple attempts. **These problems might be specific to the installation on the Atlantis, The USBL system was installed 5 years ago and to the best of our knowledge a service visit has not been conducted by Sonardyne. This should be done. Furthermore, the Ranger software configuration should contain all NDSF USBL beacons and not be changed from cruise to cruise.**
4. *Procedures should be established for configuring and testing beacons prior to deployment on CTDs or other equipment.* Throughout the cruise, there were incidents where gear went over the side without the USBL beacons being properly configured. While this is not a *Sentry* problem per se it does effect our operations it does effect our ability to efficiently operate.

T.3: DVL Failure — A failed DVL and subsequent crash forced us to abort Sentry 279. A failure analysis (see attached report) concludes that the DVL failed before *Sentry* crashed.

T.4: Acoustic Communications — On sentry280, Sentry went off the hook and appeared to be operating correctly, but it was unable to successfully send SMS messages, instead, it responded with "SMS:1009—ACK". USBL tracking was fine after a software "Force Reset" on the transceiver head 10 minutes into the dive.

Upon consulting the avtrak manual, we found that the "ACK" reply indicates that the device has no data in its queue or it has been setup in "ACK only" mode. It seems that in our case, both were to blame. We assumed that no changes had been to the avtrak since last night's successful dive, however, this may not have been correct.

The Avtrak manual states: Possible Reply Strings, for the SMS sent with `ACK ONLY` or `STD_EXCHANGE`. SMS:0101,ACK Data received okay and device had no available SMS data.

The decision was made to abort the vehicle because of the risk associated with limited comms (no SMS) over the OOI site. We thought that the problem may have been caused by a lock on the serial port as a result of a bad shutdown of minicom. We saw this earlier in the day when trying to communicate with a new DVL. We were able to communicate to the new DVL on the bench and through the vehicle's serial port over gtkterm/minicom, but dvlsend was unable to read the serial port.

Problem Determination — Once the vehicle was on deck, we confirmed that rov was not able to communicate to /dev/ttyXR3, the serial port where the avtrak was connected. We did not find a specific lock file, but upon reboot, rov logs confirmed proper comms with the avtrak. We also found an instance where minicom was used to open this serial port recently on the stack's history report.

We then discovered a second problem. It seemed that the avtrak's settings had been changed from the desired "A0: produce text message when queried" to "A1: produce ACK message when queried". All other settings appeared to be fine.

From the Avtrak manual:
SMS:1201;A0 (produces SMS msgs)
SMS:1201;A1 (produces "ACK only" msgs)
SMS:1201;A3 (produce "No response" msgs)

Conclusion — We promptly changed the setting to "A0" by typing "SMS:1201;A0" in gtkterm and checked that the setting was correct. It appears that recent software development to automatically configure the avtrak and/or terminal access to the avtrak may have caused both the lockup and the incorrect setting.

T.5: XR2 Low Battery — We noticed a low voltage (12.5V after 2 min) on XR1's battery after running the python script `"query_xr.py"` during post-dive for sentry273 (pre-dive voltages measured with the same script were OK). Confirmed results by running the script again, and then manually querying XR battery voltage levels with GTKterm with vehicle power off in sentrysitter. XR1's battery voltage held at 13.8V after re-connecting it with `#GRD/XR1!B1Y`. Further tests with `query_xr.py` and manual logging showed both XR's battery voltage holding at acceptable levels with vehicle power off ($13.8V$ for XR1, 12.7 for XR2).

No software smoking gun found. Searched for strings like "!B" in `rov/sentry_cmds` and sentry-utils and was able to rule out any possible hits. No additional "!B" commands found in rov/raw/*GRD logs after the initial calls for !B1 during start-up. Looked at XR battery voltage as reported in GRD logs, both stayed at $14V$ for the duration.

`query_xr.py` itself was used in the previous cruise (2014-Glazer), and the previous two dives (2014-Kinsey, sentry271, sentry272). Mission differences between sentry273 and sentry272 do not seeem applicable (reson OFF, edgetek OFF, nortek ON, TIM OFF, DVL's in free-run).

Plans for sentry274-post dive. Take it slow. Before/after each command issued, check XR's battery level with XR.

T.6: Battery issues during pre-dive sentry277 — We were unable to turn batterys ON during predive; all batteries reported communication errors. Errors reported were similar, but not exactly the same, as the issues experienced on the Falkor where network traffic offloading data post-dive interfered with charging the batteries. The solution on the Falkor was to issue soft-resets to the batteries through the MultiCharger program (little 'r' command sent through SAIL). This procedure re-enabled communications with the batteries this time as well. Batteries were able to be brought up and down twice without issues, and the pre-dive checklist was continued.

After discussion with group members we discovered that ROV had been run for development purposes AFTER the battery device=/dev/ttyS3 line in rov.dive.ini had been uncommented (as per the predive checklist) AND while the batteries were still being charged. The thought is ROV and MultiCharger where fighting for /dev/ttyS3, which crashed the bus.

Special care needs to be taken when coordinating predive exercies with an active engineering development effort.

6 Sentry Operations Team

The *Sentry* team was comprised of Zac Berkowitz, Al Duester, Justin Fujii, Johanna Hansen, James Kinsey, and Meme Lobecker (Leg B).

7 Acknowledgments

1. As always, the crew of the *R/V Atlantis* was great. Deck operations, engine room support, and the stewards department did their usual great job supporting our cruise.

Sentry 271 Dive Report

WHOI Sentry Operations Group
Dr. James Kinsey, Zac Berkowitz, Alan Duester, Justin Fujii, Johanna Hansen, Meme Lobecker (Leg B)

Sentry Expedition Leader: Dr. James Kinsey

Sentry PIs: Optical Modem:Norm Farr (WHOI), and Dr. Maurice Tivey (WHOI);
Heat Flux: Dr. James Kinsey (WHOI), Dr. Tim Crone (Lamont-Doherty Earth Observatory), and Professor Eric Mittelstadt (University of Idaho)
Cruise Chief Scientist: Dr. Tim Crone, Lamont-Doherty Earth Observatory

Summary

Weather: Fine.

Reason for end of dive: Mission was aborted after it was determined that *Sentry* could not drive up. See issues section for more information.

Vehicle Configuration

The science sensing suite for this dive was:

Table 1: Sentry Sensor Configuration

Sensor
APS 1540 Magnetometers (3)
Edgetech Dynamically Focused Sidescan sonar
Reson 7125 Multibeam Sonar
Seabird SBE49 Conductivity-Temperature-Depth (CTD)
Seapoint optical backscatter sensor (OBS)
Anderaa optode model 4330
300kHz RDI DVL
IXEA PHINS
Reson Sound Velocity Probe
Koichi Nakomura EH sensor
Nortek Vector Acoustic Doppler Velocimeter (ADV) — provided by Kinsey et al.
SBE 3 Temperature Sensors (3) — provided by WHOI SSSG pool
Microstrain GX3-25 MEMS IMU — provided by Kinsey et al.
1200kHz RDI DVL

This dive was navigated using the DVL/INS system in real time. USBL provided post-dive corrections.

Important Positions

Dive Origin: 45° 54.000'N 130° 4.000'W

Launch Position: 45° 55.350'N 130° 0.134'W

Narrative

The objectives of this dive were to obtain heat flux data, bathymetric, sidescan, and magnetics data of the ASHES hydrothermal field. After a brief ballast run, a 20m altitude survey was to be conducted followed by a 10m altitude survey. After this, the sonars would be secured and heat flux survey would be conducted at 10m, 20m, and 60m.

Predive and launch went smoothly as did the initial ballast run. *Sentry* did fine driving at 60, 20, and 10m. Heading servo looked good and *Sentry* drove good tracklines with the stinger on the front. Toward the end of the 10m run, a "WBFP 8 1520" was sent to raise the floor in the bottom follower 10m. The vehicle was fine at the time — this test was run to verify that *Sentry* could be commanded off the seafloor in the event of an impact or near impact. The science site is at the OOI Axial location and this is a crucial capability. Immediately after the cmd was sent, *Sentry* drove 15m down into the seafloor. Changing the depth floor or the altitude did not get *Sentry* off the seafloor..

Recovery went fine even with the stinger. Al did an excellent job driving *Sentry* in backwards and Justin, Catfish, and the deck crew got *Sentry* on board just fine. The vehicle sustained no damage because of the crash on the seafloor.

Analysis of the data revealed a combination of being negatively buoyant and 2 code bugs caused the crash. Had any one not occurred, we might have been fine. The day was spent correcting these errors and we went back in at 0930 local for an overnight dive. Thanks to Dana and Carl for their shoreside troubleshooting.

1 Issues and Proposed Solutions

The immediate cause of *Sentry* colliding with the seafloor was *Sentry* being commanded to drive up; however, there were three underlying causes:

1. *Sentry* was negatively buoyant. This is not surprising for a first dive with a new configuration. Buoyancy was added before the next dive.

2. The minimum speed parameter had been set to 0.08m/s in rov.sentry.ini during the May 2014 Van Dover cruise. Thus as *Sentry* neared the edge of the envelope it slowed to 0.08m/s. Since the vehicle was in flight mode and negatively buoyant, the decreased speed prevented *Sentry* from being able to drive up. *Sentry* effectively stalled at this point continued descending.

3. Once outside the bottom follower envelope, *Sentry* did not enter ROV mode. The bottom follower alarm (`bf.alarm`) was set but `bf.pseudo_bot_code` was equal to zero. A conditional in feedback.cpp required that both equal 1 in order for *Sentry* to enter rov mode. This conditional was changed to only use `bf.alarm` — this fixed the problem for the cruise.

   A subsequent email from Mike Jakuba (sent to sentry-engineering email list on 8/11/14) discussed the rationale for the dual conditionals. `bf.pseudo_bot_code` was added to the code to enable *Nereus* to yo-yo. This allowed *Nereus* to yo-yo while having protection from hitting the seafloor. Please see Mike's email for more detail. Because of the infrequency with which *Sentry* does yo-yos and that since the loss of *Nereus* only *Sentry* uses the bottom follower this code should be reviewed.

Dive Statistics

1.1 sentry271 Summary

Origin: 45.900000 -130.066667
Origin: 45 54.000'N 130 4.000'W
Launch: 2014/07/18 00:31:27
Survey start: 2014/07/18 01:10:10
Survey start: Lat:45.922007 Lon:-130.002490
Survey start: Lat:45 55.320'N Lon:130 0.149'W
Survey end: 2014/07/18 03:04:55
Survey start: Lat:45.929075 Lon:-130.010830
Survey start: Lat:45 55.745'N Lon:130 0.650'W
Ascent begins: 2014/07/18 03:07:40
On the surface: 2014/07/18 03:49:50

On deck: 2014/07/18 04:09:53
descent rate: 37.9 m/min
ascent rate: 36.6 m/min
survey time: 1.9 hours
deck-to-deck time 3.6 hours
Mean survey depth: 1513m
Mean survey height: 29m
distance travelled: 2.43km
average speed; 0.35m/s
average speed during photo runs: 0.12 m/s over 0.12 km
average speed during multibeam runs: 0.40 m/s over 2.30 km
total vertical during survey: 271m
Battery energy at launch: 13.2 kwhr
Battery energy at survey end: 12.0 kwhr
Battery energy on deck: 11.7 kwhr

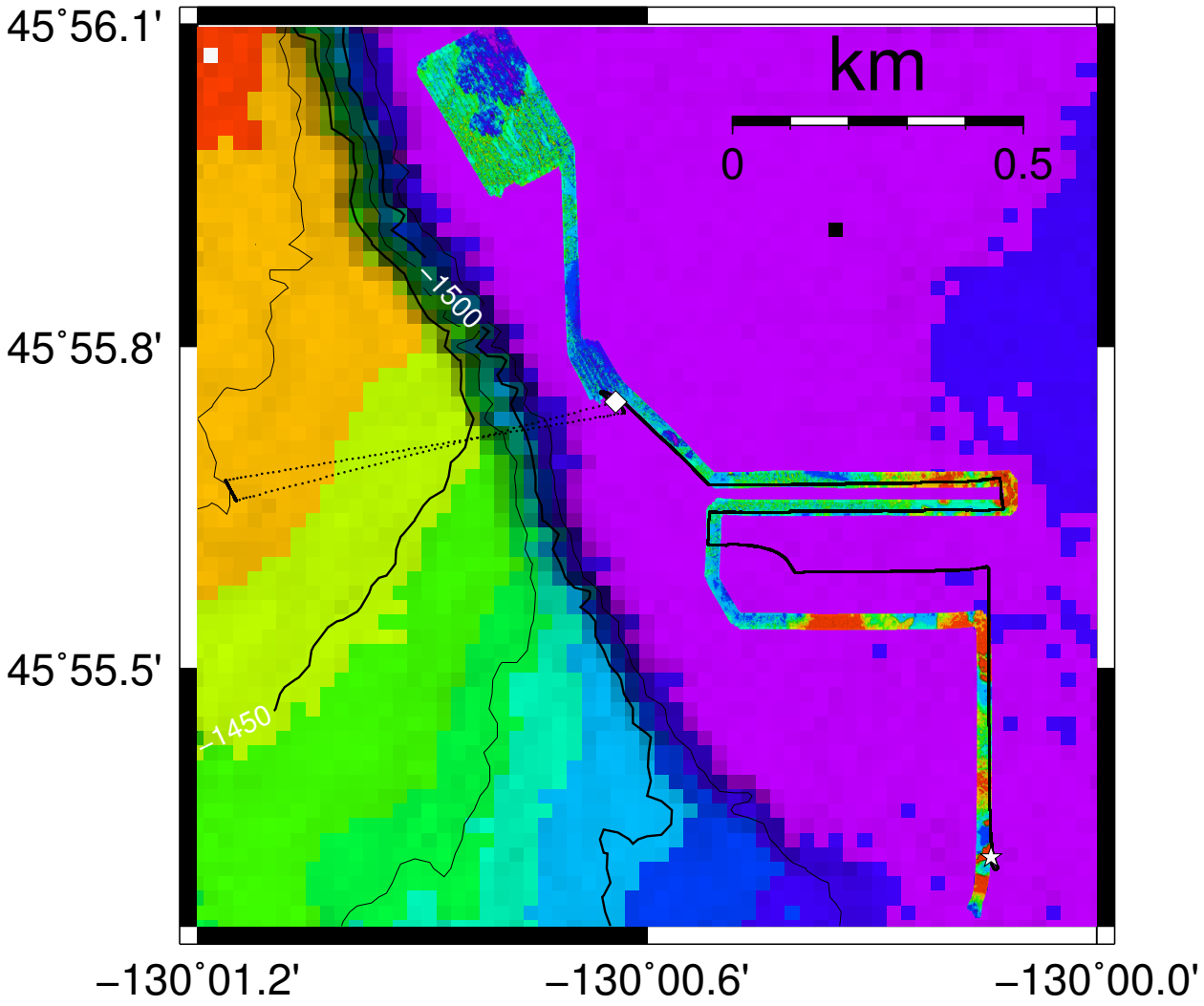

Figure 1: Navigation track (black line) for Sentry 271 with white star indicating the start of the survey and the white diamond the end of the survey. Bathymetry from Sentry 272 is overlaid on EM300 data obtained on TGT253 in 2010.

Sentry 272 Dive Report

WHOI Sentry Operations Group
Dr. James Kinsey, Zac Berkowitz, Alan Duester, Justin Fujii, Johanna Hansen, Meme Lobecker (Leg B)

Sentry Expedition Leader: Dr. James Kinsey

Sentry PIs: Optical Modem:Norm Farr (WHOI), and Dr. Maurice Tivey (WHOI);
Heat Flux: Dr. James Kinsey (WHOI), Dr. Tim Crone (Lamont-Doherty Earth Observatory), and Professor Eric Mittelstadt (University of Idaho)
Cruise Chief Scientist: Dr. Tim Crone, Lamont-Doherty Earth Observatory

Summary

Weather: Weather was not an issue for this dive.

Reason for end of dive: The mission was terminated acoustically to coordinate with *Alvin* operations. By this time all of the primary mission objectives had been accomplished.

Vehicle Configuration

The science sensing suite for this dive was:

Table 2: Sentry Sensor Configuration

Sensor
APS 1540 Magnetometers (3)
Edgetech Dynamically Focused Sidescan sonar
Reson 7125 Multibeam Sonar
Seabird SBE49 CTD
Seapoint OBS
Anderaa optode model 4330
300kHz RDI DVL
IXEA PHINS
Reson Sound Velocity Probe
Koichi Nakomura EH sensor
Nortek Vector Acoustic Doppler Velocimeter (ADV) — provided by Kinsey et al.
SBE 3 Temperature Sensors (3) — provided by WHOI SSSG pool
Microstrain GX3-25 MEMS IMU — provided by Kinsey et al.
1200kHz RDI DVL

This dive was navigated using the DVL/INS system in real time. USBL provided post-dive corrections.

Important Positions

Dive Origin: 45° 54.000'N 130° 4.000'W

Launch Position: 45° 55.350'N 130° 0.134'W

Narrative

Dive objectives were the same as Sentry271. The dive went smoothly expect for USBL tracking during descent. There was no tracking during the descent — tracking was obtained only after multiple restarts of the topside Sonardyne hardware. The code fixes implemented after the previous dive worked fine.

1 Issues and Proposed Solutions

USBL tracking during descent. See cruise technical issues section for more information.

Dive Statistics

Origin: 45.900000 -130.066667
Origin: 45° 54.000'N 130° 4.000'W

Launch: 2014/07/19 04:08:51
Survey start: 2014/07/19 04:56:46
Survey end: 2014/07/19 14:11:37
Ascent begins: 2014/07/19 14:15:18
On the surface: 2014/07/19 14:57:41
On deck: 2014/07/19 15:19:49
descent rate: 30.6 m/min
ascent rate: 34.9 m/min
survey time: 9.2 hours
deck-to-deck time 11.2 hours
Mean survey depth: 1518m
Mean survey height: 21m
distance travelled: 14.84km
average speed; 0.45m/s
average speed during photo runs: 0.41 m/s over 0.14 km
average speed during multibeam runs: 0.45 m/s over 14.70 km
total vertical during survey: 1584m
Battery energy at launch: 11.6 kwhr
Battery energy at survey end: 7.2 kwhr
Battery energy on deck: 7.1 kwhr

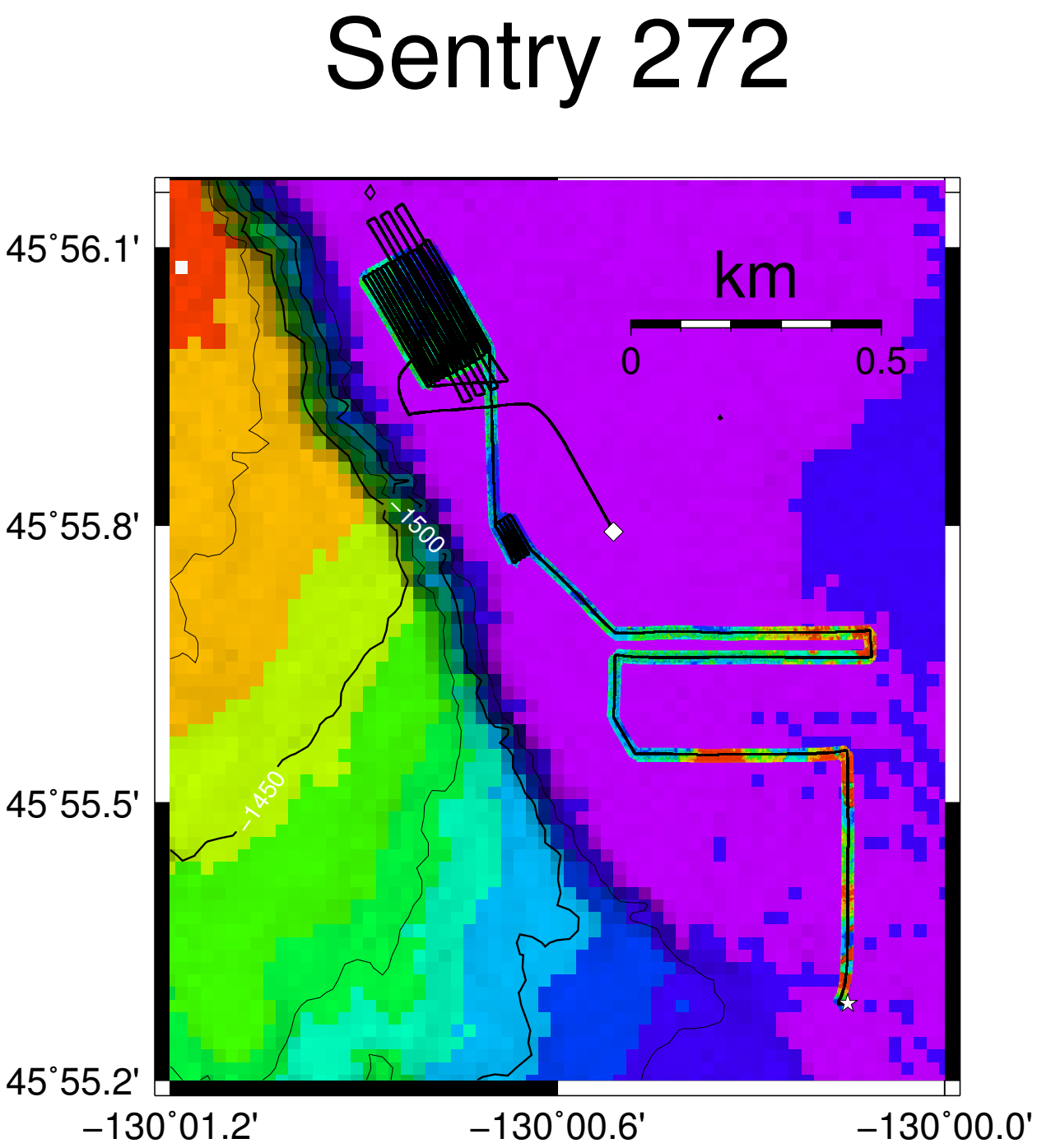

Figure 2: Navigation track (black line) for Sentry 272 with white star indicating the start of the survey and the white diamond the end of the survey. Bathymetry from Sentry 272 is overlaid on EM300 data obtained on TGT253 in 2010.

Sentry 273 Dive Report

WHOI Sentry Operations Group
Dr. James Kinsey, Zac Berkowitz, Alan Duester, Justin Fujii, Johanna Hansen, Meme Lobecker (Leg B)

Sentry Expedition Leader: Dr. James Kinsey

Sentry PIs: Optical Modem:Norm Farr (WHOI), and Dr. Maurice Tivey (WHOI);
Heat Flux: Dr. James Kinsey (WHOI), Dr. Tim Crone (Lamont-Doherty Earth Observatory), and Professor Eric Mittelstadt (University of Idaho)
Cruise Chief Scientist: Dr. Tim Crone, Lamont-Doherty Earth Observatory

Summary

Weather: Clear and calm. Not a factor for this dive.

Reason for end of dive: The mission was terminated acoustically to coordinate with *Alvin* operations. By this time all of the primary mission objectives had been accomplished.

Vehicle Configuration

The science sensing suite for this dive was:

Table 3: Sentry Sensor Configuration

Sensor
APS 1540 Magnetometers (3)
Edgetech Dynamically Focused Sidescan sonar
Reson 7125 Multibeam Sonar
Seabird SBE49 CTD
Seapoint OBS
Anderaa optode model 4330
300kHz RDI DVL
IXEA PHINS
Reson Sound Velocity Probe
Koichi Nakomura EH sensor
Nortek Vector Acoustic Doppler Velocimeter (ADV) — provided by Kinsey et al.
SBE 3 Temperature Sensors (3) — provided by WHOI SSSG pool
Microstrain GX3-25 MEMS IMU — provided by Kinsey et al.
1200kHz RDI DVL

This dive was navigated using the DVL/INS system in real time. USBL provided post-dive corrections.

Important Positions

Dive Origin: 45° 54.000'N 130° 4.000'W

Launch Position: 45° 55.808'N 130° 0.575'W

Narrative

Objectives were mapping water temperatures and velocities. No bathymetric or sidescan data was obtained. The dive went smoothly.

1 Issues and Proposed Solutions

Because of pilot error, the RF beacon was not turned on. Predive procedures were reviewed with the necessary personnel.

Dive Statistics

Origin: 45.900000 -130.066667
Origin: 45 54.000'N 130 4.000'W

Launch: 2014/07/19 23:34:46
Survey start: 2014/07/20 00:17:08
Survey end: 2014/07/20 12:32:54
Ascent begins: 2014/07/20 12:38:11
On the surface: 2014/07/20 13:10:44
On deck: 2014/07/20 13:37:14
descent rate: 35.3 m/min
ascent rate: 44.2 m/min
survey time: 12.3 hours
deck-to-deck time 14.0 hours
Mean survey depth: 1509m
Mean survey height: 30m
distance travelled: 23.23km
average speed; 0.53m/s
average speed during photo runs: 0.42 m/s over 0.05 km
average speed during multibeam runs: 0.53 m/s over 23.18 km
total vertical during survey: 2386m
Battery energy at launch: 13.1 kwhr
Battery energy at survey end: 9.1 kwhr
Battery energy on deck: 9.0 kwhr

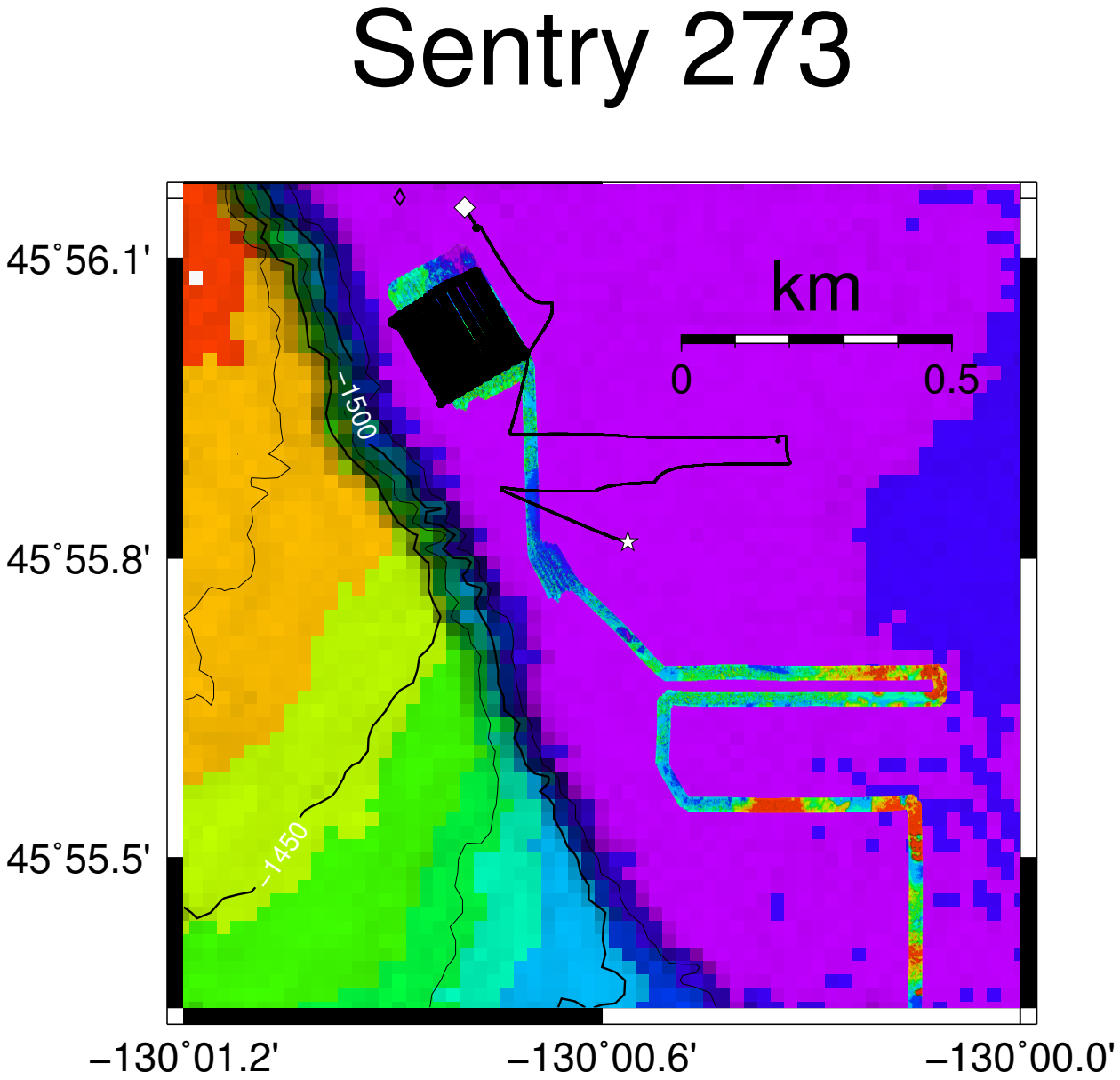

Figure 3: Navigation track (black line) for Sentry 273 with white star indicating the start of the survey and the white diamond the end of the survey. Bathymetry from Sentry 272 is overlaid on EM300 data obtained on TGT253 in 2010.

Sentry 274 Dive Report

WHOI Sentry Operations Group
Dr. James Kinsey, Zac Berkowitz, Alan Duester, Justin Fujii, Johanna Hansen, Meme Lobecker (Leg B)

Sentry Expedition Leader: Dr. James Kinsey

Sentry PIs: Optical Modem:Norm Farr (WHOI), and Dr. Maurice Tivey (WHOI);
Heat Flux: Dr. James Kinsey (WHOI), Dr. Tim Crone (Lamont-Doherty Earth Observatory), and Professor Eric Mittelstadt (University of Idaho)
Cruise Chief Scientist: Dr. Tim Crone, Lamont-Doherty Earth Observatory

Summary

Weather: Clear and calm. Not an issue for this dive.

Reason for end of dive: The mission was terminated acoustically to coordinate with *Alvin* operations. By this time all of the primary mission objectives had been accomplished.

Vehicle Configuration

The science sensing suite for this dive was:

Table 4: Sentry Sensor Configuration

Sensor
APS 1540 Magnetometers (3)
Edgetech Dynamically Focused Sidescan sonar
Reson 7125 Multibeam Sonar
Seabird SBE49 CTD
Seapoint OBS
Anderaa optode model 4330
300kHz RDI DVL
IXEA PHINS
Reson Sound Velocity Probe
Koichi Nakomura EH sensor
Nortek Vector Acoustic Doppler Velocimeter (ADV) — provided by Kinsey et al.
SBE 3 Temperature Sensors (3) — provided by WHOI SSSG pool
Microstrain GX3-25 MEMS IMU — provided by Kinsey et al.
1200kHz RDI DVL

This dive was navigated using the DVL/INS system in real time. USBL provided post-dive corrections.

Important Positions

Dive Origin: 45° 54.000'N 130° 4.000'W

Launch Position: 45° 55.808'N 130° 0.575'W

Narrative

Objectives were mapping water temperatures and velocities. No bathymetric or sidescan data was obtained (as planned). Dive went smoothly.

1 Issues and Proposed Solutions

None

Dive Statistics

Origin: 45.900000° -130.066667°
Origin: 45° 54.000'N 130° 4.000'W

Launch: 2014/07/21 01:47:50
Survey start: 2014/07/21 02:30:14
Survey end: 2014/07/21 12:25:38
Ascent begins: 2014/07/21 12:29:19
On the surface: 2014/07/21 13:00:39
On deck: 2014/07/21 13:17:14
descent rate: 34.5 m/min
ascent rate: 45.9 m/min
survey time: 9.9 hours
deck-to-deck time 11.5 hours
Mean survey depth: 1514m
Mean survey height: 25m
distance travelled: 18.37km
average speed; 0.51m/s
average speed during photo runs: 0.47 m/s over 0.10 km
average speed during multibeam runs: 0.51 m/s over 18.27 km
total vertical during survey: 1972m
Battery energy at launch: 13.6 kwhr
Battery energy at survey end: 10.3 kwhr
Battery energy on deck: 10.1 kwhr

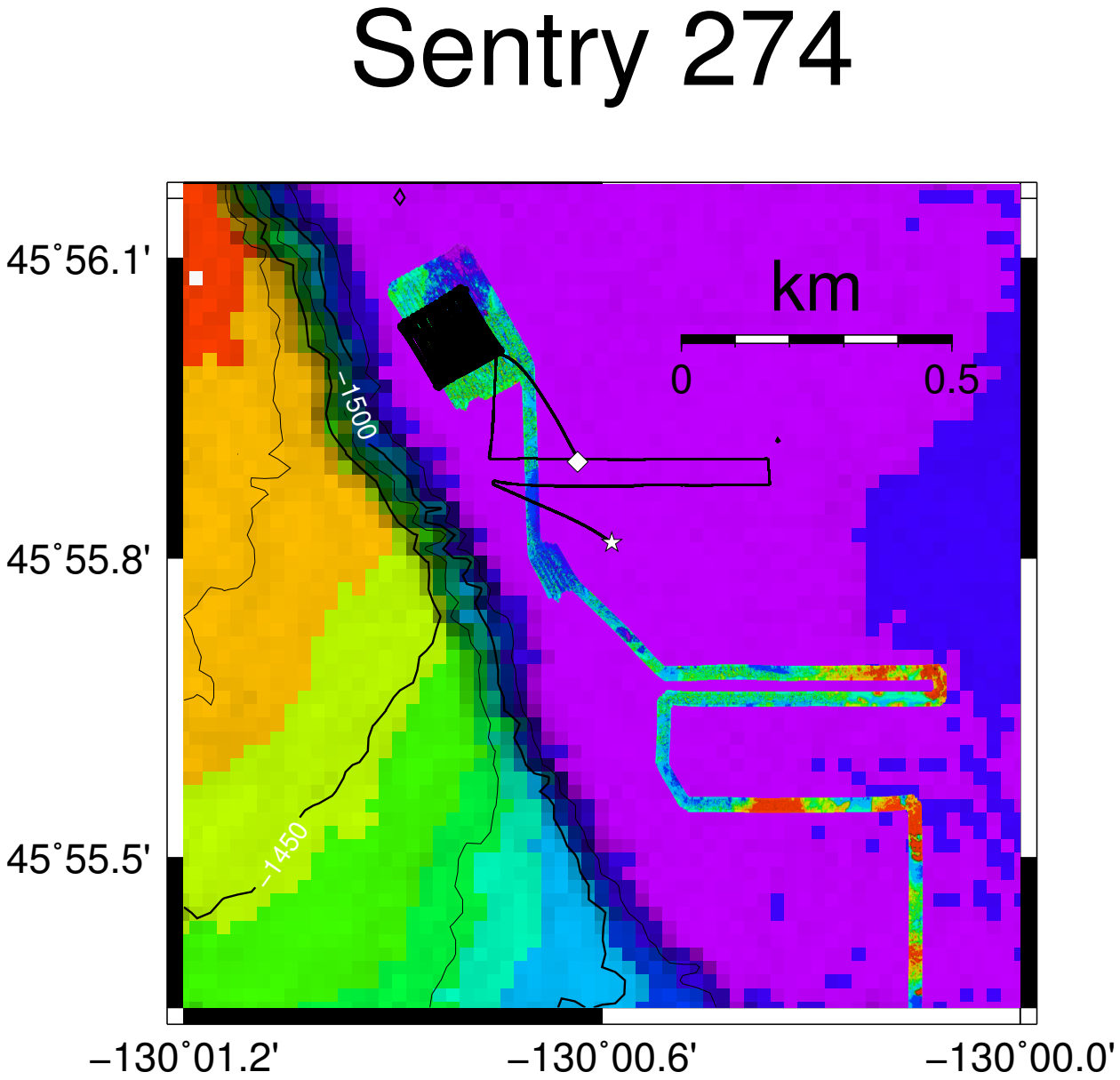

Figure 4: Navigation track (black line) for Sentry 274 with white star indicating the start of the survey and the white diamond the end of the survey. Bathymetry from Sentry 272 is overlaid on EM300 data obtained on TGT253 in 2010.

Sentry 275 Dive Report

WHOI Sentry Operations Group
Dr. James Kinsey, Zac Berkowitz, Alan Duester, Justin Fujii, Johanna Hansen, Meme Lobecker (Leg B)

Sentry Expedition Leader: Dr. James Kinsey

Sentry PIs: Optical Modem:Norm Farr (WHOI), and Dr. Maurice Tivey (WHOI);
Heat Flux: Dr. James Kinsey (WHOI), Dr. Tim Crone (Lamont-Doherty Earth Observatory), and Professor Eric Mittelstadt (University of Idaho)
Cruise Chief Scientist: Dr. Tim Crone, Lamont-Doherty Earth Observatory

Summary

Weather: Clear and calm. Not an issue for this dive.

Reason for end of dive: The mission was terminated acoustically to coordinate with *Alvin* operations. By this time all of the primary mission objectives had been accomplished.

Vehicle Configuration

The science sensing suite for this dive was:

Table 5: Sentry Sensor Configuration

Sensor
APS 1540 Magnetometers (3)
Edgetech Dynamically Focused Sidescan sonar
Reson 7125 Multibeam Sonar
Seabird SBE49 CTD
Seapoint OBS
Anderaa optode model 4330
300kHz RDI DVL
IXEA PHINS
Reson Sound Velocity Probe
Koichi Nakomura EH sensor
Nortek Vector Acoustic Doppler Velocimeter (ADV) — provided by Kinsey et al.
SBE 3 Temperature Sensors (3) — provided by WHOI SSSG pool
Microstrain GX3-25 MEMS IMU — provided by Kinsey et al.
1200kHz RDI DVL

This dive was navigated using the DVL/INS system in real time. USBL provided post-dive corrections.

Important Positions

Dive Origin: 45° 54.000'N 130° 4.000'W

Launch Position: 45° 55.808'N 130° 0.575'W

Narrative

Objectives were mapping water temperatures and velocities. No bathymetric or sidescan data was obtained (as planned). Dive went smoothly.

1 Issues and Proposed Solutions

None

Dive Statistics

1.1 sentry275 Summary

Origin: 45.900000 -130.066667
Origin: 45 54.000'N 130 4.000'W
Launch: 2014/07/22 01:03:15
Survey start: 2014/07/22 01:46:48
Survey end: 2014/07/22 12:42:06
Ascent begins: 2014/07/22 12:52:29
On the surface: 2014/07/22 13:19:25
On deck: 2014/07/22 13:37:52
descent rate: 34.3 m/min
ascent rate: 54.4 m/min
survey time: 10.9 hours
deck-to-deck time 12.6 hours
Mean survey depth: 1515m
Mean survey height: 24m
distance travelled: 20.51km
average speed; 0.52m/s
average speed during photo runs: 0.47 m/s over 0.15 km
average speed during multibeam runs: 0.52 m/s over 20.36 km
total vertical during survey: 2010m
Battery energy at launch: 13.2 kwhr
Battery energy at survey end: 9.7 kwhr
Battery energy on deck: 9.5 kwhr

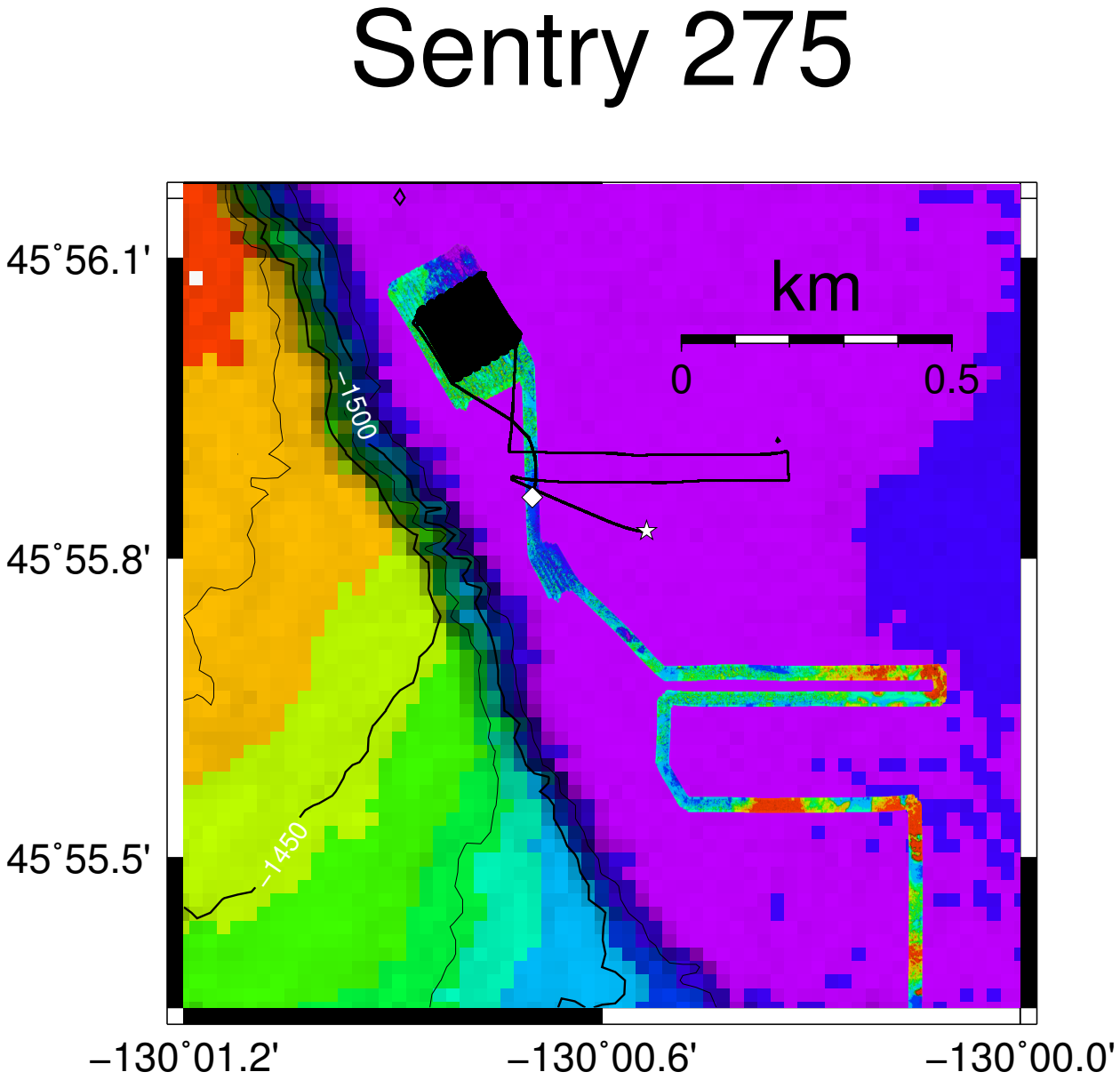

Figure 5: Navigation track (black line) for Sentry 275 with white star indicating the start of the survey and the white diamond the end of the survey. Bathymetry from Sentry 272 is overlaid on EM300 data obtained on TGT253 in 2010.

Sentry 276 Dive Report

WHOI Sentry Operations Group
Dr. James Kinsey, Zac Berkowitz, Alan Duester, Justin Fujii, Johanna Hansen, Meme Lobecker (Leg B)

Sentry Expedition Leader: Dr. James Kinsey

Sentry PIs: Optical Modem:Norm Farr (WHOI), and Dr. Maurice Tivey (WHOI);
Heat Flux: Dr. James Kinsey (WHOI), Dr. Tim Crone (Lamont-Doherty Earth Observatory), and Professor Eric Mittelstadt (University of Idaho)
Cruise Chief Scientist: Dr. Tim Crone, Lamont-Doherty Earth Observatory

Summary

Weather: Weather was not an issue for this dive.

Reason for end of dive: The mission was terminated acoustically to coordinate with *Alvin* operations. By this time all of the primary mission objectives had been accomplished.

Vehicle Configuration

The science sensing suite for this dive was:

Table 6: Sentry Sensor Configuration

Sensor
APS 1540 Magnetometers (3)
Edgetech Dynamically Focused Sidescan sonar
Reson 7125 Multibeam Sonar
Seabird SBE49 CTD
Seapoint OBS
Anderaa optode model 4330
300kHz RDI DVL
IXEA PHINS
Reson Sound Velocity Probe
Koichi Nakomura EH sensor
Nortek Vector Acoustic Doppler Velocimeter (ADV) — provided by Kinsey et al.
SBE 3 Temperature Sensors (3) — provided by WHOI SSSG pool
Microstrain GX3-25 MEMS IMU — provided by Kinsey et al.
1200kHz RDI DVL

This dive was navigated using the DVL/INS system in real time. USBL provided post-dive corrections.

Important Positions

Dive Origin: 47° 53.634'N, 129° 9.870'W

Launch Position: 47° 56.737'N 129° 5.858'W

Narrative

The objective of this dive was heat flux and mapping survey over southern portion of Main Endeavor Field centered over the Bastille vent. *Sentry* was programmed to: (1) Fly 5m trackline spacing at 20m altitude obtaining water temperature and velocity, multibeam, sidescan, and magnetics data; (2) repeat pattern described in (1) at 40m with 5m trackline spacing obtaining just water temperature, water velocity, and magnetics data; (3) repeat pattern described in (1) at 60m with 10 m trackline spacing obtaining just water temperature, water velocity, and magnetics data; and (4) repeat (1-3) four times.

The dive went smoothly with no vehicle or operations problems expect for USBL tracking during descent. There was no tracking during the descent — tracking was obtained only after multiple restarts of the topside Sonardyne hardware.

Because this is a study site for the Neptune Canada Observatory (i.e., there is seafloor cables and instrumentation) we established a drop site 300m south of Bastille.

1 Issues and Proposed Solutions

USBL tracking during descent. See cruise technical issues section for more information.

Dive Statistics

1.1 sentry276 Summary

Origin: 47.8939 -129.1645
Origin: 47° 53.634'N, 129° 9.870'W
Launch: 2014/07/24 23:57:04
Survey start: 2014/07/25 00:59:57
Survey end: 2014/07/25 11:52:11
Ascent begins: 2014/07/25 11:55:00
On the surface: 2014/07/25 12:43:49
On deck: 2014/07/25 13:05:24
descent rate: 33.9 m/min
ascent rate: 43.5 m/min
survey time: 10.9 hours
deck-to-deck time 13.1 hours
Mean survey depth: 2150m
Mean survey height: 37m
distance travelled: 18.78km
average speed; 0.48m/s
average speed during photo runs: 0.42 m/s over 0.02 km
average speed during multibeam runs: 0.48 m/s over 18.75 km
total vertical during survey: 4926m
Battery energy at launch: 13.4 kwhr
Battery energy at survey end: 6.9 kwhr
Battery energy on deck: 6.7 kwhr

Sentry 276

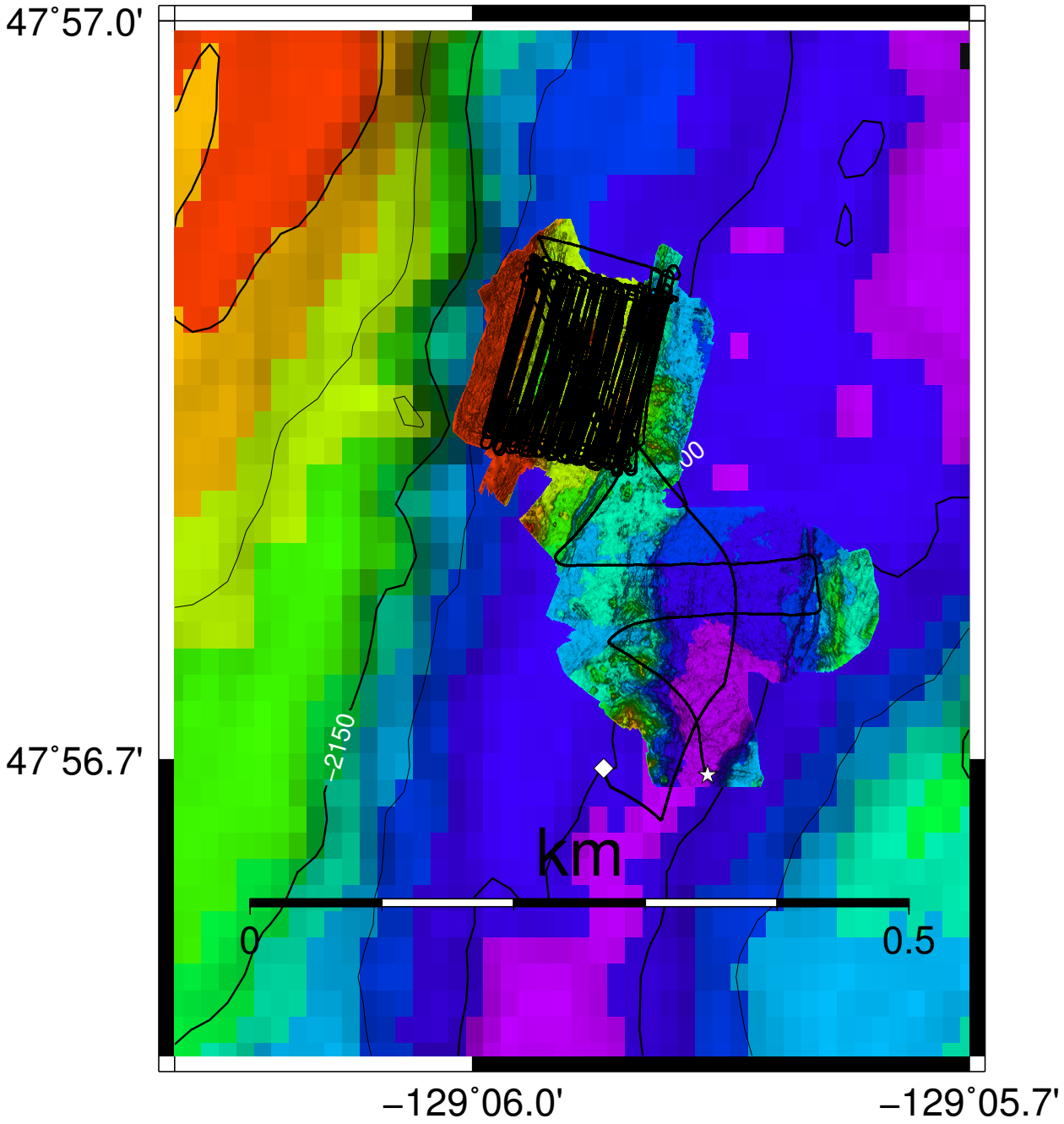

Figure 6: Navigation track (black line) for Sentry 276 with white star indicating the start of the survey and the white diamond the end of the survey. Bathymetry from Sentry 276 is overlaid on EM300 data.

Sentry 277 Dive Report

WHOI Sentry Operations Group
Dr. James Kinsey, Zac Berkowitz, Alan Duester, Justin Fujii, Johanna Hansen, Meme Lobecker (Leg B)

Sentry Expedition Leader: Dr. James Kinsey

Sentry PIs: Optical Modem:Norm Farr (WHOI), and Dr. Maurice Tivey (WHOI);
Heat Flux: Dr. James Kinsey (WHOI), Dr. Tim Crone (Lamont-Doherty Earth Observatory), and Professor Eric Mittelstadt (University of Idaho)
Cruise Chief Scientist: Dr. Tim Crone, Lamont-Doherty Earth Observatory

Summary

Weather: Clear and calm. Not a factor this dive.

Reason for end of dive: The mission was terminated acoustically to coordinate with Alvin operations. By this time all of the primary mission objectives had been accomplished.

Vehicle Configuration

Table 1 lists the science sensing suite for this dive.

Table 7: Sentry Sensor Configuration

Sensor
Optical Communication System (OCS)
APS 1540 Magnetometers (3)
Reson 7125 AUV3 Multibeam Sonar
Seabird SBE49 CTD
Seapoint OBS
Anderaa optode model 4330
300kHz RDI DVL
IXEA PHINS
Reson Sound Velocity Probe
Koichi Nakomura EH sensor

This dive was navigated using the DVL/INS system in real time. USBL provided post-dive corrections. All final navigation tracks are the best effort interpretation of available data by skilled personnel.

Important Positions

Dive Origin: 47° 49.98'N, 128° 46.002'W

Launch Position: 47° 53.669'N, 128° 38.4666'W

Narrative

Sentry dive 277 was focused on proving system integration with the optical communications system. This included quantifying the file transfer capabilities, determining the parameters needed for an optical power survey, and testing acoustic range finding.

Automatic and requested file transfer were proven during this dive. The Sentry mission was developed so that an initial 50 m survey was flown before Sentry narrowed into a small watch circle 50 m above the lander. The OCD was instructed by the mission to automatically begin a 100 MB transfer at the beginning of the launch circle when optical state is confirmed good. This piece worked flawlessly, with the transfer initiating on its own shortly after the command was received by OCD from the mission executor. After the automatic transfer, the topside team initiated several additional transfers. These included one transfer that was initiated just as Sentry was flying out of optical range. The transfer stopped when the optical link was broken, the it picked back up at its expected speed as soon as the link was made again. The team also powered off and on the optical transmitter from the topside through the OCD and then initiated a new file transfer.

Due to time constraints, only the initial optical power survey at 50 m was completed. This however, provided a great baseline for the next dive, proving that the power characteristics that the OCS team had calculated were correct.

The acoustic range finding algorithm was able to locate the lander and report its calculated mission shift from within the initial 50m survey, thus proving its utility.

Overall, the expectations for this dive were met. A flaw in the OCD logging system, was recovered through separate data logs. The team exercised Sentry's turning radius and station keeping with the tight transfer circle. Messages were able to be passed between all of the various systems, making this integration a success.

Operationally, Sentry worked well. The only vehicle issue was the continued absence of USBL during descent. Tracking was obtained only after multiple restarts of the topside Sonardyne hardware.

1 Issues and Proposed Solutions

1. An OCD logging system error caused the program to write over its log file after the size of the file reached 1 GB. Unfortunately, this occurred just after the vehicle surfaced. However, the OCS and ROV were both logging their respective messages and states, allowing the data to be pieced back together after time-syncing. The logging error was a result of a misunderstanding on how the python library, RotatingFileHandler, actually named the log files and was corrected well before the next dive.

2. It was suspected that the acoustic ranging was not performing as well as they could, but they data was not conclusive. No action was taken, so as not to jeopardize the next dive.

3. USBL tracking during descent. See cruise technical issues section for more information.

Dive Statistics

1.1 sentry277 Summary

sentry277 Summary
Origin: 45.900000 -130.066667
Origin: 45 54.000'N 130 4.000'W
Launch: 2014/07/29 06:54:15
Survey start: 2014/07/29 08:02:47
Survey start: Lat: Lon:
Survey start: Lat: 'S Lon: 'W
Survey end: 2014/07/29 12:08:10
Survey start: Lat: Lon:
Survey start: Lat: 'S Lon: 'W
Ascent begins: 2014/07/29 12:09:13
On the surface: 2014/07/29 13:04:09
On deck: 2014/07/29 13:08:18
descent rate: 37.3 m/min
ascent rate: 46.5 m/min
survey time: 4.1 hours
deck-to-deck time 6.2 hours
Mean survey depth: 2552m
Mean survey height: 50m

distance travelled: 10.34km
average speed; 0.70m/s
average speed during photo runs: NaN m/s over NaN km
average speed during multibeam runs: 0.70 m/s over 10.34 km
total vertical during survey: 854m
Battery energy at launch: 13.6 kwhr
Battery energy at survey end: 11.5 kwhr
Battery energy on deck: 11.3 kwhr

Plots and Images

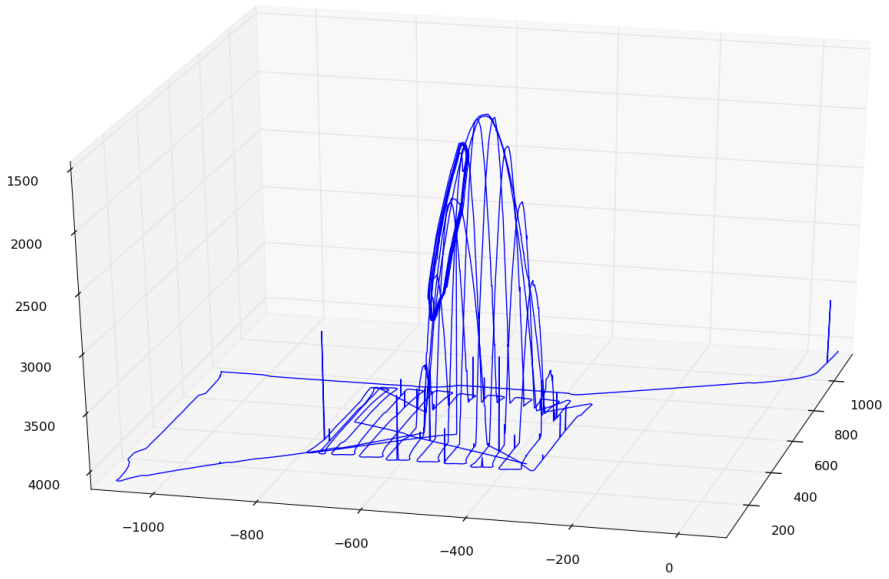

Figure 7: Optical Power Map

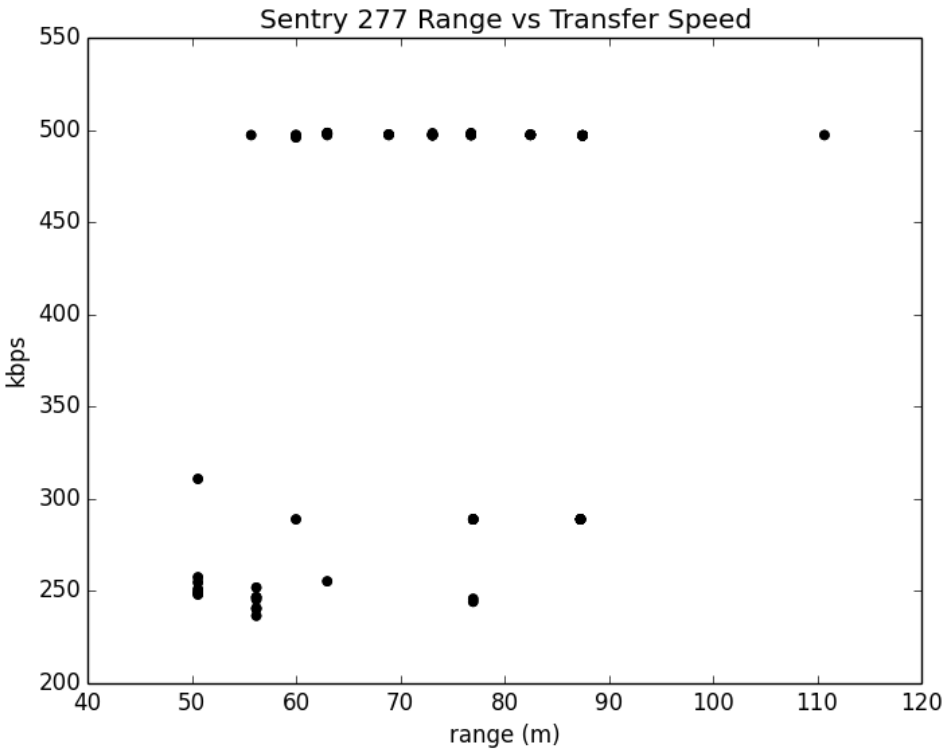

Figure 8: Range when Data Transfer Occurs vs Transfer Speed

Sentry 278 Dive Report

WHOI Sentry Operations Group
Dr. James Kinsey, Zac Berkowitz, Alan Duester, Justin Fujii, Johanna Hansen, Meme Lobecker (Leg B)

Sentry Expedition Leader: Dr. James Kinsey

Sentry PIs: Optical Modem:Norm Farr (WHOI), and Dr. Maurice Tivey (WHOI);
Heat Flux: Dr. James Kinsey (WHOI), Dr. Tim Crone (Lamont-Doherty Earth Observatory), and Professor Eric Mittelstadt (University of Idaho)
Cruise Chief Scientist: Dr. Tim Crone, Lamont-Doherty Earth Observatory

Summary

Weather: Clear and calm. Not a factor this dive.

Reason for end of dive: The mission was terminated acoustically to coordinate with Alvin operations. By this time all of the primary mission objectives had been accomplished.

Vehicle Configuration

Table 1 lists the science sensing suite for this dive.

Table 8: Sentry Sensor Configuration

Sensor
Optical Communication System (OCS)
APS 1540 Magnetometers (3)
Reson 7125 AUV3 Multibeam Sonar
Seabird SBE49 CTD
Seapoint OBS
Anderaa optode model 4330
300kHz RDI DVL
IXEA PHINS
Reson Sound Velocity Probe
Koichi Nakomura EH sensor

This dive was navigated using the DVL/INS system in real time. USBL provided post-dive corrections. All final navigation tracks are the best effort interpretation of available data by skilled personnel.

Important Positions

Dive Origin: 48° 25.0020'N, 128°43.998'W

Launch Position: 48° 26.508'N, 128°42.05399'W

Narrative

This dive's primary objective was to the provide the first full optical power map of the OCS. This was made possible by Sentry's ability to quickly fly precise patterns over the lander.

The survey box was centered over the lander and extended approximately 50 m past the optical power cutoff range for each altitude: 25 m, 50 m, 75 m, 100 m, 125 m, 150 m.

This dive went smoothly and provided the data necessary for the OCS team to develop precise models of their system's behavior. The only vehicle issue was the continued absence of USBL during descent. Tracking was obtained only after multiple restarts of the topside Sonardyne hardware.

Issues and Proposed Solutions

1. Acoustic Ranging was limited 200 meters or less. This raised suspicion in the previous dive and was proven during this post-dive analysis. The optical team increased the receive wait time on their master Avtak6 to try to resolve this problem.

2. USBL tracking during descent. See cruise technical issues section for more information.

Dive Statistics

0.2 sentry278 Summary

sentry278 Summary
Origin: 45.900000 -130.066667
Origin: 45 54.000'N 130 4.000'W
Launch: 2014/07/31 01:42:16
Survey start: 2014/07/31 02:44:35
Survey start: Lat:45.929080 Lon:-130.010682
Survey start: Lat:45 55.745'N Lon:130 0.641'W
Survey end: 2014/07/31 12:29:16
Survey start: Lat: Lon:
Survey start: Lat: 'S Lon: 'W
Ascent begins: 2014/07/31 12:32:25
On the surface: 2014/07/31 13:18:21
On deck: 2014/07/31 13:27:48
descent rate: 38.2 m/min
ascent rate: 49.4 m/min
survey time: 9.7 hours
deck-to-deck time 11.8 hours
Mean survey depth: 2343m
Mean survey height: 77m
distance travelled: 30.32km
average speed; 0.86m/s
average speed during photo runs: NaN m/s over NaN km
average speed during multibeam runs: 0.86 m/s over 30.32 km
total vertical during survey: 1907m
Battery energy at launch: 13.4 kwhr
Battery energy at survey end: 7.5 kwhr
Battery energy on deck: 7.3 kwhr

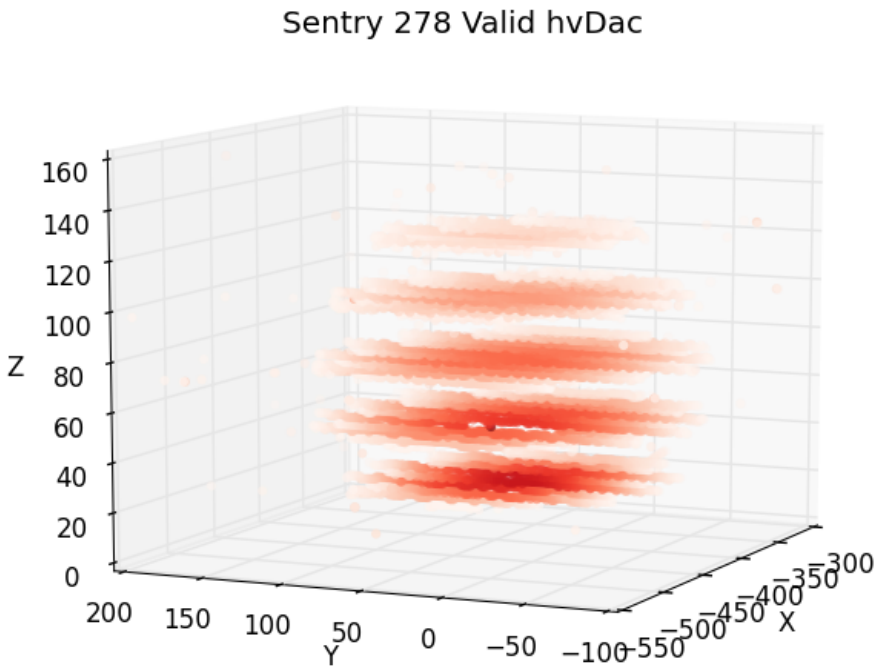

Figure 9: Optical Transmit Power

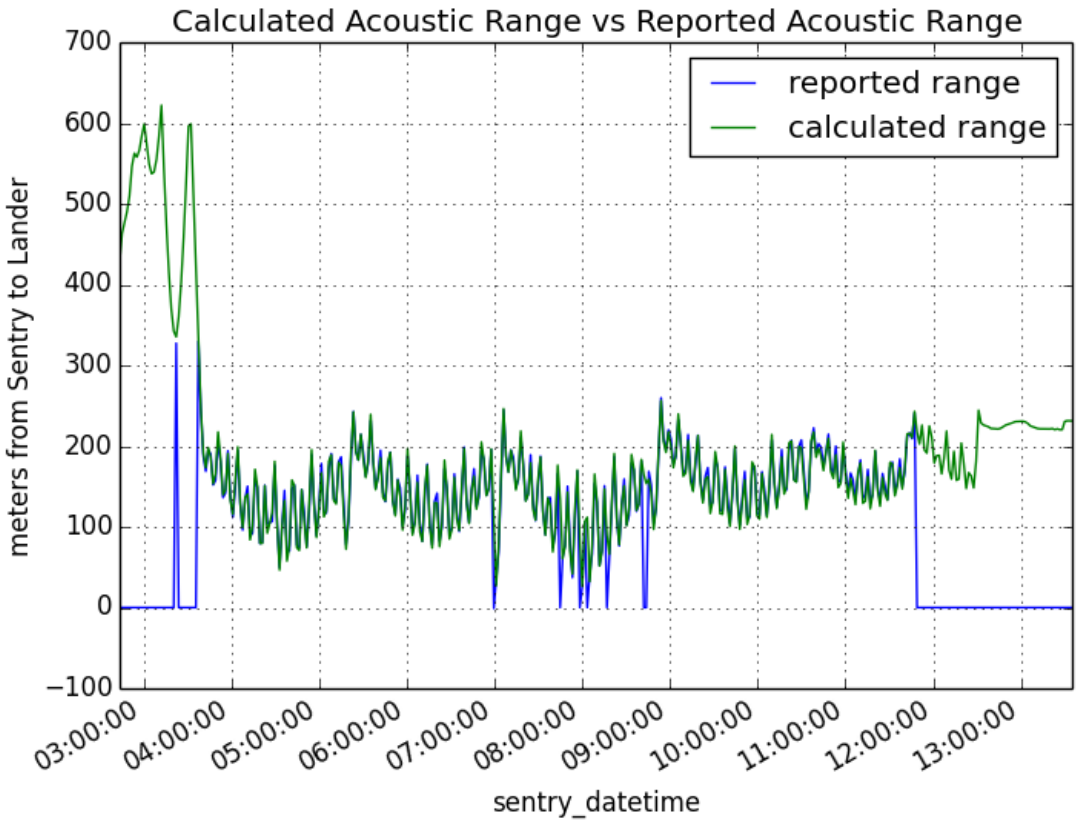

Figure 10: Calculated Acoustic Range vs Reported Acoustic Range. Note that valid ranges were only reported for 200m or less.

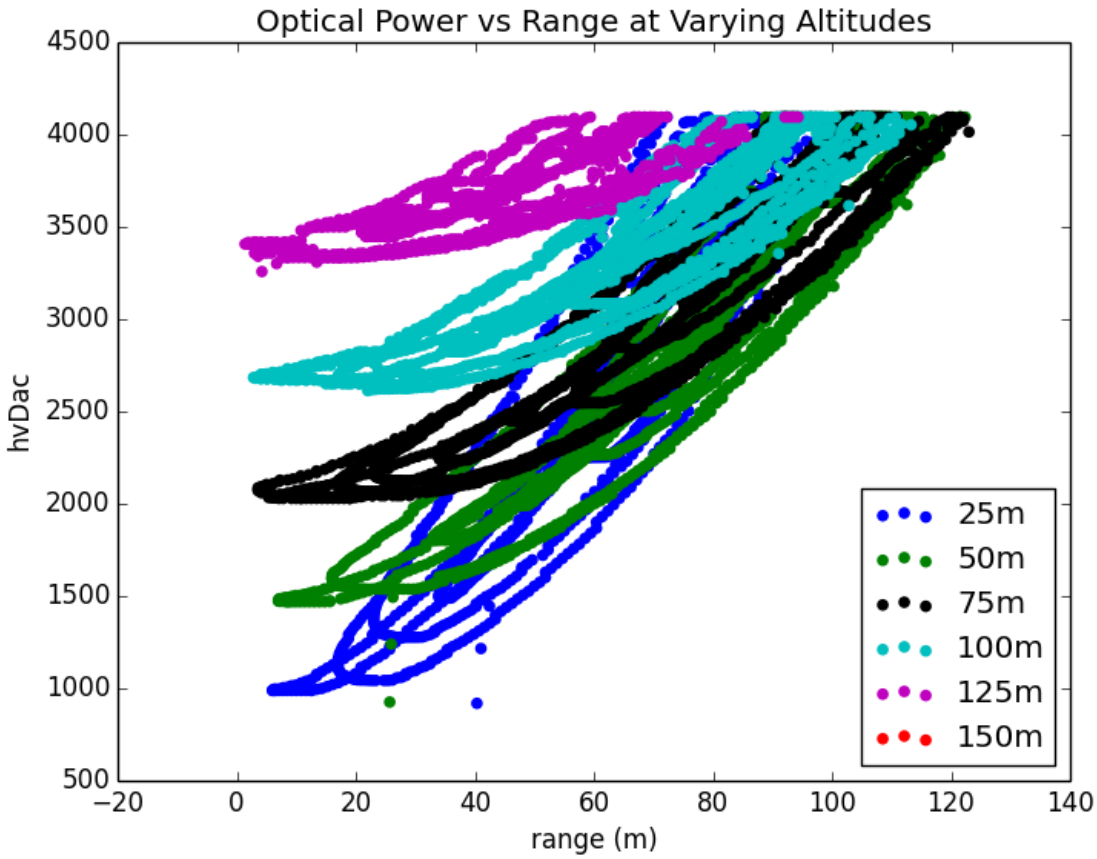

Figure 11: Optical power measured at different altitudes.

Sentry 279 Dive Report

WHOI Sentry Operations Group
Dr. James Kinsey, Zac Berkowitz, Alan Duester, Justin Fujii, Johanna Hansen, Meme Lobecker (Leg B)

Sentry Expedition Leader: Dr. James Kinsey

Sentry PIs: Optical Modem:Norm Farr (WHOI), and Dr. Maurice Tivey (WHOI);
Heat Flux: Dr. James Kinsey (WHOI), Dr. Tim Crone (Lamont-Doherty Earth Observatory), and Professor Eric Mittelstadt (University of Idaho)
Cruise Chief Scientist: Dr. Tim Crone, Lamont-Doherty Earth Observatory

Summary

Weather: Clear and calm. Not a factor this dive.

Reason for end of dive: The mission was terminated acoustically after a failure occurred with the DVL approximately 2 hours into the dive. The DVL failure caused impact with the seafloor that caused slight damage to the OMS and extensive damage to the DVL.

Vehicle Configuration

Table 1 lists the science sensing suite for this dive.

Table 9: Sentry Sensor Configuration

Sensor
Optical Communication System (OCS)
APS 1540 Magnetometers (3)
Reson 7125 AUV3 Multibeam Sonar
Seabird SBE49 CTD
Seapoint OBS
Anderaa optode model 4330
300kHz RDI DVL
IXEA PHINS
Reson Sound Velocity Probe
Koichi Nakomura EH sensor

This dive was navigated using the DVL/INS system in real time until the DVL failure occurred. After the DVL stopped reporting seafloor range values, Sentry navigated on an internal model for several minutes before the dive was terminated. USBL provided post-dive corrections. All final navigation tracks are the best effort interpretation of available data by skilled personnel.

Important Positions

Dive Origin: 45° 54.0'N, 130°4.002'W

Launch Position: 45° 55.62'N, 130°0.132'W

Narrative

The success in the two previous optical dives allowed for the team attempt several high risk/high reward techniques. This included doubling the optical transmit rate and implementing two real-time localization algorithms. The dive was planned with successively more autonomy. In early stages the OCD would acoustically transmit recommended commands to the ship and the human would send those commands. Later in the dive, Sentry would execute these commands without any human intervention.

Sentry was 2 hours late getting into the water due to last-minute testing and debugging of the newly implemented optical geolocation algorithm. Since the desired dive time was only 3 hrs, the delay was a worthwhile investment into making sure the system worked.

USBL tracking was again absent during descent. Tracking was obtained only after multiple restarts of the topside Sonardyne hardware. Unfortunately, a failure in the DVL ended the dive early. This failure caused Sentry to lose navigation ability and crash into the seafloor.

There was also a problem with the Avtrak6 acoustic ranging that prevented acoustic range finding. The log files indicate that a valid acoustic range was never received. This may have been introduced as a result of

the OCS team increasing the receiver listen time on the Avtrak master. An error introduced when parsing the 106 message prevented optical power from being collected real-time, thus negating the utility of the optical localization work.

1 Issues and Proposed Solutions

1. Sentry's primary navigation sensor, the DVL 300, failed during the first two hours of the dive. When the DVL failed, it stopped reporting beam range values. A new change in the Navest caused ROV to hold on to the last known DVL value. This caused the vehicle to fly into the ground, as it believed that it was still at the altitude reported by navest, despite changing ground conditions. The impact with the seafloor completely ruined the DVL necessitating a dive abort. Additional information about the DVL failure can be found in the RDI 300 DVL Failure Report.

2. The OCS system never reported a valid range value. This may have been caused by changes made to the Avtrak6 to increase receiving time.

3. The OCD was unable to parse message type 106 coming from the OCS because of an additional character on the end of the string. This precluded real-time optical geolocation.

4. During pre-dive testing of the mission controller simulator, it was discovered that the AUV UDP message that is broadcast in this environment reports heading in degrees, while the vehicle reports this value in radians. The heading value also did not wrap correctly.

5. USBL tracking during descent. See cruise technical issues section for more information.

Dive Statistics

1.1 sentry279 Summary

sentry279 Summary
Origin: 45.900000 -130.066667
Origin: 45 54.000'N 130 4.000'W
Launch: 2014/08/02 06:18:41
Survey start: 2014/08/02 07:00:09
Survey start: Lat: Lon:
Survey start: Lat: 'S Lon: 'W
Survey end: 2014/08/02 09:34:19
Survey start: Lat: Lon:
Survey start: Lat: 'S Lon: 'W
Ascent begins: 2014/08/02 09:37:04
On the surface: 2014/08/02 10:09:34
On deck: 2014/08/02 10:37:54
descent rate: 36.3 m/min
ascent rate: 45.9 m/min
survey time: 2.6 hours
deck-to-deck time 4.3 hours

Mean survey depth: 1496m
Mean survey height: 48m
distance travelled: 6.95km
average speed; 0.75m/s
average speed during photo runs: NaN m/s over NaN km
average speed during multibeam runs: 0.75 m/s over 6.95 km
total vertical during survey: 813m
Battery energy at launch: 13.5 kwhr
Battery energy at survey end: 12.0 kwhr
Battery energy on deck: 11.7 kwhr

Sentry 280 Dive Report

WHOI Sentry Operations Group
Dr. James Kinsey, Zac Berkowitz, Alan Duester, Justin Fujii, Johanna Hansen, Meme Lobecker (Leg B)

Sentry Expedition Leader: Dr. James Kinsey

Sentry PIs: Optical Modem:Norm Farr (WHOI), and Dr. Maurice Tivey (WHOI);
Heat Flux: Dr. James Kinsey (WHOI), Dr. Tim Crone (Lamont-Doherty Earth Observatory), and Professor Eric Mittelstadt (University of Idaho)
Cruise Chief Scientist: Dr. Tim Crone, Lamont-Doherty Earth Observatory

Summary

Weather: Weather was fine.

Reason for end of dive: Terminated dive after failing to achieve acoustic communication with the vehicle.

Vehicle Configuration

The science sensing suite for this dive was:

Table 10: Sentry Sensor Configuration

Sensor
APS 1540 Magnetometers (3)
Edgetech Dynamically Focused Sidescan sonar
Reson 7125 Multibeam Sonar
Seabird SBE49 CTD
Seapoint OBS
Anderaa optode model 4330
300kHz RDI DVL
IXEA PHINS
Reson Sound Velocity Probe
Koichi Nakomura EH sensor
Nortek Vector Acoustic Doppler Velocimeter (ADV) — provided by Kinsey et al.
SBE 3 Temperature Sensors (3) — provided by WHOI SSSG pool
Microstrain GX3-25 MEMS IMU — provided by Kinsey et al.
1200kHz RDI DVL

This dive was navigated using the DVL/INS system in real time. USBL provided post-dive corrections.

Important Positions

Dive Origin: 45° 54.000'N, 130° 4.000' W

Launch Position: 45° 55.808'N, 130° 0.575'W

Narrative

The objective of this dive was to obtain temperature and water velocity data over 36 hours at the ASHES hydrothermal vent field — enabling to estimate heat flux over multiple tidal cycles. Prior to starting the science survey, a brief engineering test was planned to test the new DVL.

Predive and launch proceeded smoothly. USBL tracking was not available after launch nor was acoustic communications via the USBL system. USBL tracking was restored during the descent. Bottom approach went fine and based on USBL tracking the vehicle was doing fine. The initial tracklines were flown without incident indicating that the replacement DVL was working fine. The continued acoustic communications outage resulted in the decision to abort the dive. Under normal circumstances we would have continued the dive however the close proximity to OOI infrastructure on this dive made continuing a foolhardy decision. An acoustic abort was issued via the XRs. Ascent and recovery occurred without incident.

1 Issues and Proposed Solutions

Acoustic Communication — Acoustic communications failed during this dive. Post dive analysis showed that there were no serial communications between the PC104 stack and the Avtrak during the dive. There were two causes for this faliure:

1. The Avtrak serial port was locked by minicom. This occurred accidentally while diagnosing the DVL after dive 279 — the Avtrak port (ttyXR3) was opened instead of the 300kHz DVL port (ttyXR8). Minicom was removed from the stack. **Minicom is unreliable and should never be used on the stack!**
2. The Avtrak configuration had been changed. No explanation can be provided for this although there is no evidence that someone worked with the unit between dive 279 and 280. Similar occurrences were reported earlier in the cruise with Alvin and SSSG Avtraks. **We should consider an automated script to configure and verify Avtraks during the predive.**
3. USBL tracking during descent. See cruise technical issues section for more information.

Dive Statistics

1.1 sentry280 Summary

Origin: 45.900000 -130.066667
Origin: 45 54.000'N 130 4.000'W
Launch: 2014/08/03 08:20:07
Survey start: 2014/08/03 09:06:34
Survey end: 2014/08/03 09:44:43
Ascent begins: 2014/08/03 09:45:58
On the surface: 2014/08/03 10:20:23
On deck: 2014/08/03 10:56:53
descent rate: 32.6 m/min
ascent rate: 44.4 m/min
survey time: 0.6 hours
deck-to-deck time 2.6 hours
Mean survey depth: 1517m
Mean survey height: 22m
distance travelled: 1.19km
average speed; 0.52m/s
average speed during photo runs: NaN m/s over NaN km
average speed during multibeam runs: 0.52 m/s over 1.19 km
total vertical during survey: 209m
Battery energy at launch: 13.4 kwhr
Battery energy at survey end: 12.9 kwhr
Battery energy on deck: 12.7 kwhr

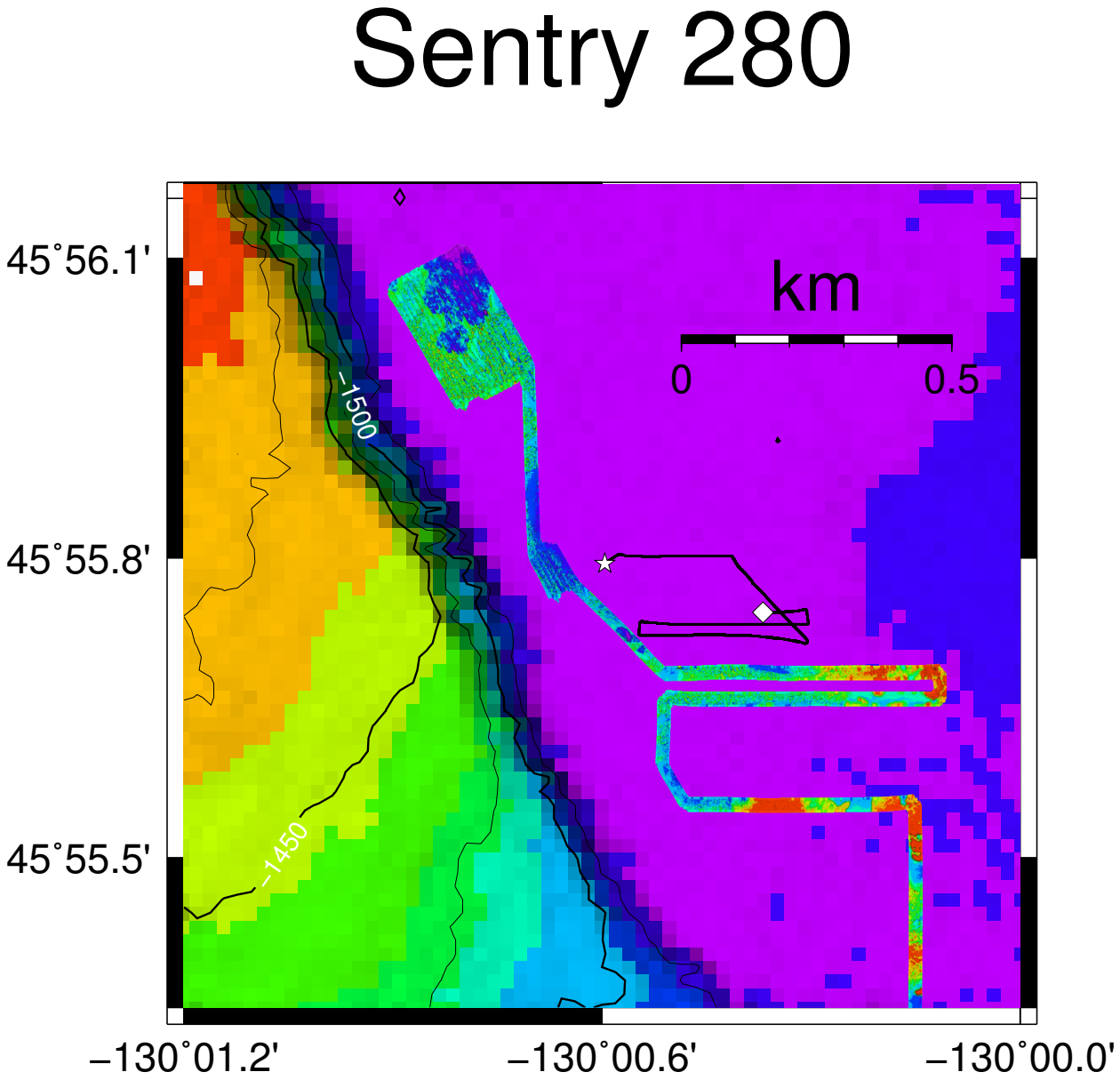

Figure 12: Navigation track (black line) for Sentry 280 with white star indicating the start of the survey and the white diamond the end of the survey. Bathymetry from Sentry 272 is overlaid on EM300 data obtained on TGT253 in 2010.

Sentry 281 Dive Report

WHOI Sentry Operations Group
Dr. James Kinsey, Zac Berkowitz, Alan Duester, Justin Fujii, Johanna Hansen, Meme Lobecker (Leg B)

Sentry Expedition Leader: Dr. James Kinsey

Sentry PIs: Optical Modem:Norm Farr (WHOI), and Dr. Maurice Tivey (WHOI);
Heat Flux: Dr. James Kinsey (WHOI), Dr. Tim Crone (Lamont-Doherty Earth Observatory), and Professor Eric Mittelstadt (University of Idaho)
Cruise Chief Scientist: Dr. Tim Crone, Lamont-Doherty Earth Observatory

Summary

Weather: Clear and calm. Not an issue for this dive.

Reason for end of dive: Mission ended when the XR long-term deadman expired.

Vehicle Configuration

The science sensing suite for this dive was:

Table 11: Sentry Sensor Configuration

Sensor
APS 1540 Magnetometers (3)
Edgetech Dynamically Focused Sidescan sonar
Reson 7125 Multibeam Sonar
Seabird SBE49 CTD
Seapoint OBS
Anderaa optode model 4330
300kHz RDI DVL
IXEA PHINS
Reson Sound Velocity Probe
Koichi Nakomura EH sensor
Nortek Vector Acoustic Doppler Velocimeter (ADV) — provided by Kinsey et al.
SBE 3 Temperature Sensors (3) — provided by WHOI SSSG pool
Microstrain GX3-25 MEMS IMU — provided by Kinsey et al.
1200kHz RDI DVL

This dive was navigated using the DVL/INS system in real time. USBL provided post-dive corrections.

Important Positions

Dive Origin: 45° 54.000'N 130° 4.000'W

Launch Position: 45° 55.808'N 130° 0.575'W

Narrative

The dive objective was an extended heat flux survey of the ASHES vent field over multiple tidal cycles. To achieve this mission, Sentry first drove test lines southeast of the ASHES vent field. before proceeding northwest to ASHES — first at 20m and then at 10m. Sentry then flew a 10m high, 5m spaced trackline survey. After the lawn was mowed, Sentry flew the south, east, and north perimeter of the box before diagonally crossing over to the start of the survey pattern. This pattern was programmed to be repeated 12 times. Each lawn mowing/perimeter survey took 4 hours.

Overall the dive was a success with Sentry in the water for 40.5 hours. The only issue was the XR long-term deadman dropping the weights — miscommunication within the team led to the timer being set 4 hours shorter than it should have been. This is a minor issue as the mission would have been acoustically aborted 2 hours later to ensure recovery in time to leave station and a 40 hour dive satisfied the science objectives.

1 Issues and Proposed Solutions

XXX

Dive Statistics

1.1 sentry281 Summary

Origin: 45.900000 -130.066667
Origin: 45 54.000'N 130 4.000'W
Launch: 2014/08/03 22:49:49
Survey start: 2014/08/03 23:31:17
Survey start: Lat:45.930027 Lon:-130.010211
Survey start: Lat:45 55.802'N Lon:130 0.613'W
Survey end: 2014/08/05 14:55:21
Survey start: Lat:45.932613 Lon:-130.013591
Survey start: Lat:45 55.957'N Lon:130 0.815'W
Ascent begins: 2014/08/05 15:02:15
On the surface: 2014/08/05 15:16:05
On deck: 2014/08/05 15:22:60
descent rate: 35.5 m/min
ascent rate: 78.2 m/min
survey time: 39.4 hours
deck-to-deck time 40.6 hours
Mean survey depth: 1527m
Mean survey height: 12m
distance travelled: 69.76km
average speed; 0.49m/s
average speed during photo runs: 0.32 m/s over 0.30 km
average speed during multibeam runs: 0.49 m/s over 69.45 km
total vertical during survey: 7906m
Battery energy at launch: 13.6 kwhr
Battery energy at survey end: 2.7 kwhr
Battery energy on deck: 2.7 kwhr