Expanding opportunites for science with Sentry, Alvin and WaveGlider

Highlights and tips from AT50-21 to East Pacific Rise
9° 45’N to 10° 06’N

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**Expedition goals**

- Monitor the volcanic and hydrothermal systems at the East Pacific Rise (EPR) axis between 9° 45’N and 10° 06’N
- Primary objectives, by vehicle:

  - Collected vent fluids
  - Recovered & redeployed temperature loggers, tide gauge, current meter
  - Imaging
  - **HOV Alvin**

  - Mapping: multibeam and other bathymetry products
  - **AUV Sentry**

  - ‘Over the horizon’ communications with *Sentry* during rock coring, CTD deployments
  - Monitor *Sentry* during full, simultaneously-operated *Alvin* dive
  - **WaveGlider**
WaveGlider for ‘Over the horizon’ communications with *Sentry* during rock coring, CTD deployments

- Many of our AUV *Sentry* dives occurred in 8-hour overnight time periods.

- Used WaveGlider to carry out ‘over the horizon’ communications to the AUV while other work was done in parallel.

- Total of 10 days/nights of simultaneous activities, which permitted the collection of 13 rock cores (out of 24 total this cruise) and 4 CTD casts (out of 11 total this cruise).

- Rock coring at the northern extent of our study area (≈9°54’N to ≈10°N) aided by newly generated *Sentry* multibeam/bathymetry products.

- Nearly half of all rock coring and CTD operations were conducted simultaneously with *Sentry* operations.
WaveGlider for *Sentry* dive with full, simultaneously-operated *Alvin* dive

- *Sentry* 714 was launched at 2000L, with the goal to carry out a 24-hour dive, starting with plume surveys over YBW and concluding with a mapping survey. *Atlantis* remained on station with *Sentry* during the night, to provide real-time sensor data to science watch standers via Sonardyne SMS system.

- At 0500L, the *Sentry* and *Alvin* ELs met to make a go/no go decision. At 0600L, the *Sentry* mission continued as planned, with monitoring from WaveGlider as *Atlantis* transited 13 km south to launch the small elevator and *Alvin*.

- At 0700L, deployed small elevator. At 0800L, *Alvin* 5248 proceeded at V vent: PIT dive, small elevator, 5:56 hours bottom time.

- Following elevator recovery and *Alvin* recovery, we transited north to recover WaveGlider, then *Sentry*. 
An extended *Sentry* mission enabled targeted characterization of a dynamic plume above a complex hydrothermal site.
During “waffle” characterization, *Sentry* altitude was adapted to uncover complex plume morphology by monitoring streaming *in situ* measurements.
An extended *Sentry* mission enabled mapping a new region, following plume characterization, simultaneous with full Alvin dive.

Sentry 714 preliminary multibeam coverage

AL5248 final dive track with UTC time
Using waveglider successfully begins with pre-cruise planning, consideration of science objectives for Sentry

- It is only possible to conduct Sentry-Alvin sim ops when both vehicles and WaveGlider are performing well.

- It is best to plan in blocks: blocks of back to back 8-hr overnight dives (during 12 hours in the water), or blocks of back to back 21-hour sim ops dives (during 24 hours in the water)

- If the science party has the WaveGlider, but is just interested in parallel over-the-side night ops, then communicate early with the Sentry group to set expectations to do 8 hour dives

- For longer cruises, it is **ok to plan to do some alternate blocks** of each dive duration: e.g., 12 hours in, 12 hours out, 12 in, 12 out, 24 hours out, 24 hours in, 24 hours out, 24 in, 24 out, etc.

- It is **not a good plan to alternate short Sentry dives with long dives**; e.g., 12, 24, 12, 24, because this pattern would impose a schedule on Sentry that does not promote rest and the maintenance of watch schedules

- Note: it takes 12 hours minimum on deck to recharge Sentry prior to its next dive
Planning the sim ops day: Choosing dive objectives for *Sentry* during sim ops *Sentry-Alvin* dives

- After establishing that the three vehicles are reliably working well, the next step is to identify sufficient science objectives for *Sentry* to justify a long dive.

- In our case, we identified a time-sensitive, multi-hour science objective that would not have been possible *without* the extra *Sentry* dive time provided by sim ops.

- Alternatively, if the primary goal for *Sentry* is multibeam mapping, long *Sentry* dives with sim ops will increase bottom coverage that will add up over time. E.g. for our 2500 m depth site:
  
  - Over a 48 hour interval, following 12 hours in, 12 hours out sequence: ~17 hours of bottom time/48 hrs
  
  - Over a 48 hour interval, following 24 hours in, 24 hours out sequence: ~21 hours of bottom time/48 hrs for ~20% more bottom time

- Work with *Sentry* team during pre-cruise period to discuss optimal map shape for a ~24 hour box. A well-planned 24 hour box will minimize turns while optimizing crossing lines.
Planning the sim ops day: Selecting a good operations sequence for Sentry-Alvin dives

- We recommend beginning with only the AUV in the water.

- We began the dive with Sentry in the water many hours before Alvin was scheduled to dive, so that we could establish that Sentry was working well before launching Alvin.

- The ELs agreed on a go/no go decision time (~0500L) which gives the option to recover the AUV early without overly impacting the planned Alvin dive.

- Factor in contingency time to accommodate other planned recoveries in the POD (e.g., elevator, WaveGlider).
Planning the sim ops day: Organizing the pre-dive briefing

- The sim ops pre-dive briefing takes place the night before the long Sentry dive begins (2 nights before the Alvin dive). It should be scheduled so that it can be integrated into the routine Alvin pre-dive briefing.

- Personnel at our sim ops pre-dive briefing included the Alvin and Sentry ELs, the Alvin pilot(s), the Chief Scientist, and 1-2 science observers. Also recommend including the Top Lab surface controller.

- Ensures ELs, Alvin pilot, Top Lab, science observers are fully briefed and have thought through each possible scenario that may be somewhat unique to each dive (e.g., distance between vehicles, bathymetry considerations, weather forecast)

- Consider how an aborted dive would be handled, for either vehicle

- Close communication between pilot-port observer-Alvin-Top Lab-Alvin EL-Sentry EL is needed throughout the Alvin dive, especially if any delays or changes occur.

- Effective communication is essential to sim ops. The challenging part is not the mission programming. Rather, it is making sure that contingency plans are in place and followed.