Highlighting Alvin Science Capabilities

photo by L. Lamar



- We are fortunate to have the most productive and capable human occupied research submarine for the US science community.
- Alvin is incorporating new science capabilities to ensure that it remains at the cutting edge of deep submergence science.
- The upcoming overhaul/upgrade completion offers an opportunity to continue the momentum for this vehicle in its 6500m capable form.



Alvin + Sentry Cooperation

- achieved and a deeper understanding of the context of seafloor observations and samples.
- with no detriment to Alvin operations.

 In recent years, the pairing of Alvin or Jason with Sentry has provided an increase in the efficiency with which many scientific objectives can be

 The typical pacing of Alvin + Sentry operations has been Alvin during the day and Sentry at night. A recent cruise (Kurz, Mittelstaedt) proved the capability of an autonomous surface vessel to tend Sentry and enable concurrent operations that yield nearly 1.5x the amount of Sentry coverage







Enabling OTH work during Sentry operations



- On AT40-02, after establishing the robustness of comms, *Atlantis* left *Sentry* for 4-8h (20km) for other night ops, while maintaining contact via satellite.
- The WaveGlider easily transited between stations (up to 40km) while Alvin was in the water and did not need to be recovered during the 18 days on station.
- After the WG capability was proven, Sentry dove over a 30h period, including an Alvin dive day.





The 'bonus' daily coverage rate (1.4x) will only increase as vehicle endurance improves.



- WaveGlider (WG) tended 15 Sentry dives over two deployments
- WG position and comms wellintegrated into topside watchstander station
- Nominal 4-6 hrs "bonus" science time per 12 hr Sentry dive.
- 30 hr Sentry dive yielded 38% improved coverage rate via plus 15 hrs bonus.
- Negligible degradation in map \bullet quality from loss of USBL!



Jakuba et al., 2018



- to ship), and shipping.
- This operation was run with an extra Sentry operator (M. Jakuba), but it is anticipated to not require additional personnel in the future.
- In the event of a Sentry abort, Alvin would need to be recovered prior to retrieving Sentry.
- Contact Sean Kelley (<u>skelley@whoi.edu</u>) for cost estimates.

Accessing this capability

 The technology for WaveGlider-tended Sentry operations is robust, but there are additional costs associated with ASV rental, satellite communications (ASV

Alvin upgrade completion

- Atlantis is scheduled for a mid-life refit in Spring 2020*.
- also complete the upgrade to 6500m capability.
- The 6500m Alvin will be ready for operations in 2021 and now is a great time to start developing and submitting proposals to use this new capability.

*There may be availability for Alvin in early 2020.

During the mid-life, Alvin will undergo it's regularly scheduled overhaul, but will





6500m operations

- Alvin operations at 6500m should closely resemble current operational modes with a goal to provide comparable bottom times.
- Current vertical speeds over 40m/min should enable bottom times at 4500-5500m consistent with past Alvin dives at shallower depths (~5h). At greater depths a slightly extended dive day would yield comparable bottom times.
- Improved energy efficiency will enable greater endurance and higher degrees of maneuverability at all dive depths.

Based on 2016 Alvin Energy Analysis

Target Depth (meters)	2500	4500	6500	6500
Dive Day Time (hours)	9	9	9	11
Descent/Ascent Rates (m/min)	40	40	40	40
Calculated Vertical Transit Time (hours)	2.1	3.8	5.4	5.4
Available Bottom Time (hours)	6.9	5.3	3.6	5.6
Bottom Time based on Avg Energy Consumption (hours)	7	5.3	3.6	5.4
Limiting factor	energy	time	time	energ





6500m replacement systems

Completed in 2018

- General arrangement and weight and balance
- 200 ft³ foam (in hand) and testing to be completed
- Sea water pump designed, delivery expected
- Main hydraulic system designed and procured
- Motor controller housings and thrusters completed; installation on Alvin has started.

To be completed in 2019

- Foam shape final design and fabrication
- Salt water pump final acceptance testing
- Hydraulic plant assembly and testing
- Ballast Sphere fabrication
- Implodable volume replacement effort
- Life support testing

Aft bay foam blocks

Ballast spheres



P & S motor control housings

Salt water pump Hydraulic plant

Expanded operational areas





Trenches: Petit Spots



Abyssal Plain: Seafloor mining







Slow-Ultraslow Ridges





Kinsey & German, 2013

Transform faults



Additional science support capabilities

- Sub-to-ship data/image transfer based on Sentry acoustic comms protocol.
- In-hull event logging capability building off Jason event logger/virtual van.
- Harmonized science interface for instrumentation (Jason = Alvin = Sentry)



Exchange of operational concepts and technology between the vehicle systems

- Alvin is an amazing vehicle that brings your eyes and mind to the seafloor.
- Significant similarity in capabilities between the ROV and HOV with upcoming increased depth range.
- <u>Now is the time</u> to begin developing proposals that will take advantage of Alvin's existing and new capabilities out of the upcoming overhaul to ensure continuity of utilization.

