WASHINGTON STATE DEPARTMENT OF
Natural Resources
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Division of Geology and Earth Resources
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REMOTELY OPERATED VEHICLE (ROV) VIDEO INVESTIGATION OF TWO LARGE SEAFLOOR MOUNDS IN SOUTHERN HOOD CANAL, WASHINGTON

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WASHINGTON DEPARTMENT OF FISH AND WILDLIFE

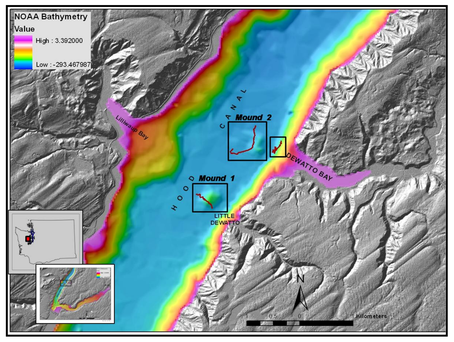
ABSTRACT

Division of Geology and Earth Resources (DGER) and Division of Aquatic Resources (DAR) of WA-Department of Natural Resources and WA-Department of Fish and Wildlife (WDFW) conducted a joint survey near DeWatto Bay in southern Hood Canal, Puget Sound, Washington, to investigate two seafloor dome-shaped features (mounds) reported earlier. We made direct visual observations on these two mounds by using a remotely operated vehicle (ROV), Saab-Seaeye Falcon, operated from a small boat navigated by the WDFW crew.

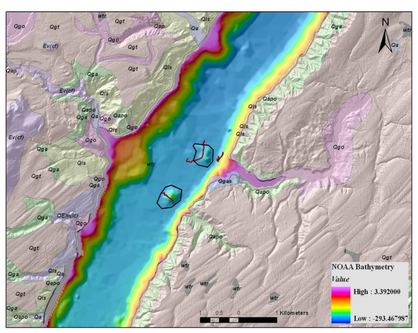
The ROV video observations are consistent with on-going 7.5-minute quadrangle mapping in the Lilliwaup, where bathymetry DEM's have been used to identify an additional twelve smaller suspected submarine landslides, most originating from delta fronts. The traversed mounds are mostly composed of well-rounded, cobble-sized clasts that appear much like compact Olympic provenance outwash gravels and tills found just above sea level in the bluffs of DeWatto Bay and in the submarine scarp at the mouth of the bay. While most other streams that empty into Hood Canal have deltas, both DeWatto River and Little DeWatto lack deltas, further evidence for submarine collapse and suggesting relatively recent events. A previous study suggested that the mounds are drumlins, however their shapes are inconsistent with Puget Lowland drumlins, which are larger and more streamlined than the DeWatto mounds. Suggestions that the mounds may be natural gas seeps are dispelled by the coarseness of the observed mound material. The inferred headwalls of both mounds are very steep, leaving little lateral support of the shoreline, and thus may be subject to future sub-aerial or submarine failures. One such failure has been mapped on the south shore of DeWatto Bay.

This pilot interagency joint effort shows that investigating and mapping seafloor geological hazards and geomorphologic conditions to better understand geologic evolution of the seafloor environment and its relation with current anthropogenic, geological mass wasting and nearby freshwater activities are essential for understanding the habitat in Puget Sound, and in coastal area and major lakes of Washington State. This joint venture, while focused on geologic features in Hood Canal, also proved to be quite informative to the WDFW biologists who participated. Specifically, video documentation of several species of rockfish was obtained from an area that cannot be easily surveyed by traditional WDFW assessment methods. This anecdotal information has provided WDFW marine fish scientists with valuable insight into the spatial distribution and habitat use by rockfish in Hood Canal that will be used to design future rockfish assessment surveys.

LOCATION and SETTING



Two topographic mounds (1 and 2) in southern Hood Canal, located west of Dewatto Bay and Little Dewatto Bay, and a small NE-SW investigated area located in between the Mound 1 and Deawatto Bay. Red lines inside the boxes show the ROV's track lines where the video observations took place. Gray and color-coded images show the Lidar topography and bathymetry (NOAA), respectively.



1:100,000-scale geology map as an overlay on Lidar image. Red lines show the ROV track lines, dome-shaped features are marked (black polygons). NOAA bathymetric image is given in colr coded form. Both the south and north mounds represent erosional remnants of large landslide blocks, comprised of semi-consolidated glacial outwash and/or glacial deltaic sediments (Qapo -Outwash Pre-fraser?).

The rounded clasts originated in a fluvial environment (glacial outwash?). These sand and gravel deposits appear to be semi-to-well consolidated, and locally sustain steep slope gradients on the east flank of the mound

Semi-consolidated well rounded sand and gravel deposits observed on the top section of the mounds.

CONCLUSIONS

The video observations visually show that mounds are likely landslide deposits due to:
- The coarseness of deposits (no gas seeps occurrences were observed);
- Apparent cohesiveness, the mounds appear to be large cohesive blocks of clasts similar to well cemented coarse gravel deposits in the headwall and surrounding areas;
- Color, the orange staining and dark color of the clasts is consistent with outwash and till from the Olympic Range;
- Texture of some clasts, the fissured surface of many of the clasts is consistent with textures of clasts that are scattered along beaches derived from adjacent bluffs;
- There are no deltas associated with the DeWatto drainages, whereas most other streams that empty into the canal have well-formed deltas;
- Hummocky bathymetry adjacent to the mounds is consistent with hummocky terrain associated with subaerial landslides.
- A steep headwall at the mouths of the drainages and the mound deposit areas is consistent with landslide morphology.
- Seismic profiles of the deposits reported by Chien-Hom (2007) are consistent with landslide deposits.

References

Matthew Chien-Hom (2007). Mysterious mounds of southern Hood Canal: dumpsites, landslide deposits, or glacial debris. Senior thesis, School of Oceanography, University Washington, Seattle, Washington.

Mark Holmes (personal communications) (2008)

Pacunski, R.E., W.A. Palsson, H.G. Greene and D. Gunderson. 2008. Conducting Visual Surveys with a Small ROV in Shallow Water, in J.R. Reynolds and H.G. Greene (eds.). Marine Habitat Mapping Technology for Alaska. Alaska Sea Grant AK-SG-08-03, pp. 109-128.

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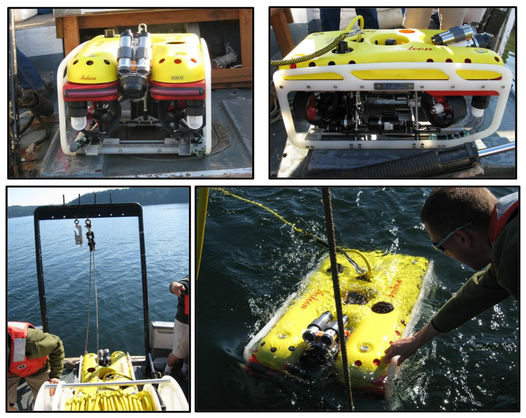
NOAA bathymetry image (2005) Combined bathymetry and topography of the Puget Lowlands, Washington State (tile: g1235475). Data originator; David Finlayson, School of Oceanography, University of Washington [accessed February 11, 2009 at http://www.ocean.washington.edu/data/pugetsound/]

Remotely Operated Vehicle (ROV) Operation



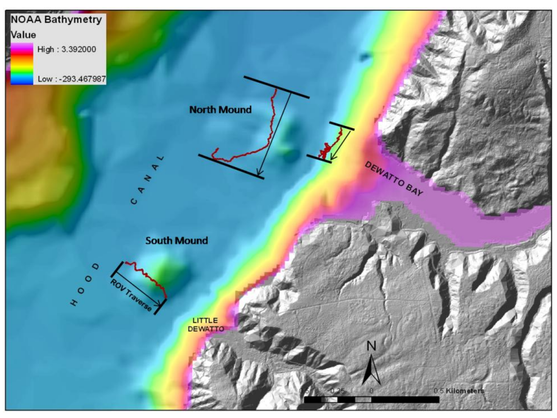
Remotely operated vehicle (ROV) – paired lasers mounted on top of camera (front and side views on top figures), lowering and early testing the elements of the ROV (bottom pictures).

ROV operations were conducted using the methods described in Pacunski et al. (2008). The support vessel used in this study was the 12 m *R/V* Molluscan, owned and operated by WDFW. The ROV was tracked with a Linkquest TrackLink 1500 ultra-short baseline (USBL) acoustic tracking system, which provided real-time geo-positioning of the vehicle throughout each deployment. A pair of green lasers aligned in parallel (10 cm separation) were mounted on top of the video camera to provide a scalar reference for the collected video imagery. However, a failure of the mounting bracket resulted in a loss of alignment and a concomitant convergence of the laser beams. Based on the lead ROV pilot's experience, it was estimated that the beam spread at nominal camera tilt angle (40-50°) and ROV height-off-bottom (~0.25-0.5 m) ranged between 2 and 8 cm. To facilitate spatial analysis of substrate features and fish distribution, the position of the ROV (lat/long) was imprinted on the videotapes with a PISCES text overlay system.

Navigation and ROV operation room (top left), TrackLink acoustic transducer used to locate ROV position (top right), video monitor and ROV electronic operating unit (bottom left), and research boat navigation monitors and control room (bottom right).

Using a video camera mounted onto a remotely operated submersible vehicle (ROV), sediments exposed on the surface of the south mound were observed and characterized. The ROV was piloted along E-W and NW-SE traverses, between 0.25 m and 1 m above the surface of the mound. The first run was from east to west over the Little DeWatto mound.

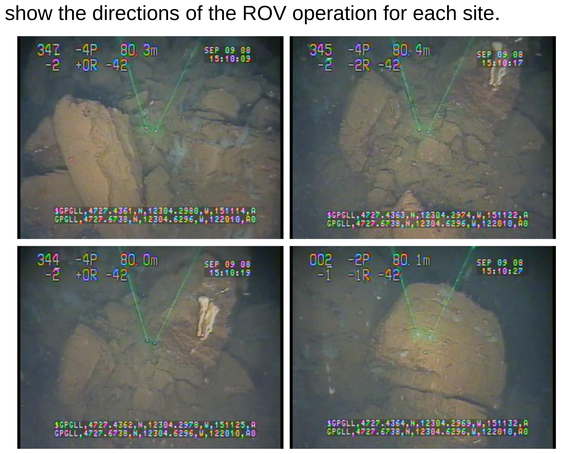
Surface sediments comprising the lower flanks of the mound consist of reddish-brown silt and clay. Accumulations of organic detritus are pervasive. This detritus consists of fall-out from dead marine organisms descending from the photic zone (Figure 3a). At the base of the mound the surface sediment is very fine grained with spot prawn burrows, pinch bug holes, and sea whips. Cobbles and boulders were observed near the top of the mound, on the east side of the mound, respectively; no matrix visible (inconsistent with gas seep interpretation). Bottom is orange-stained dark-colored boulders similar to nearby Olympic provenance rocks. Cloud sponges present on top of mounds, indicating a solid substrate, as that is what they require for anchoring.



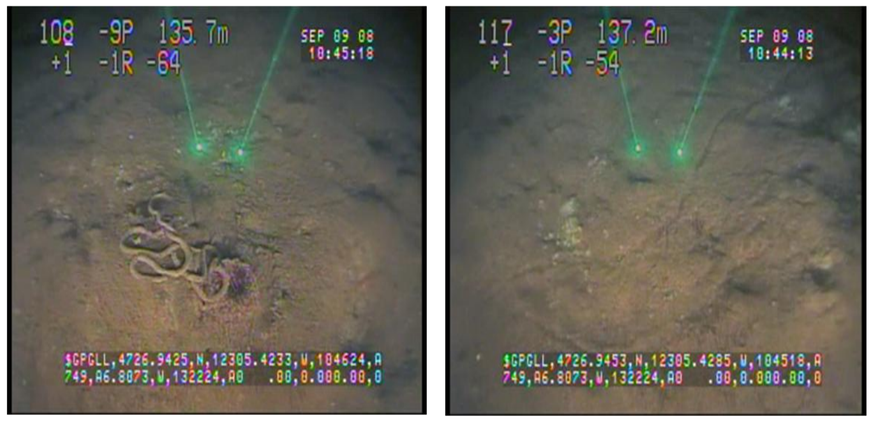
ROV track lines traversing the north and south mounds, and operated parallel to shoreline near the Dewatto Bay. Arrows show the directions of the ROV operation for each site.

These fine (soft) sediments are host to benthos marine fauna (epifauna and infauna). Burrowing anemone (Pachycerianthus fimbriatus), white sea whips (Osteocella septentrionalis), marine worms, ratfish (*Hydrolagus colliei*), and flatfish species, are present. This soft substrate has undergone bioturbation resulting in a pocketed and/or undulating surface. The surface irregularities of the lower flanks of the mound may also reflect coarse substrate (cobbles and boulders) buried beneath a blanket of fine sediment

At the base of the mound the surface sediment is very fine grained with spot prawn burrows, pinch bug holes, and sea whips.



There are large blocks of till (with protruding boulders) at 83m. Large chunks or blocks of consolidated silt are observed at 78-75m



Burrowing anemone (Pachycerianthus fimbriatus)