The Impact of Methane Flux on the Washington Margin: Glass Sponge Reefs and Massive Krill Swarms

Preliminary Results of

Three Cruises to the Grays Canyon Region of the Washington Shelf

(2007, 2008 and 2009),

sponsored by

Washington Sea Grant

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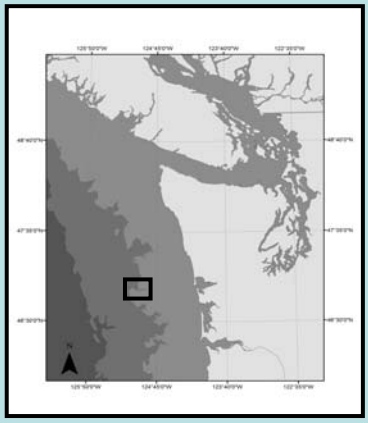
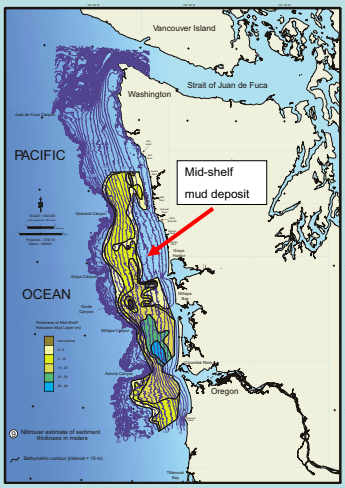
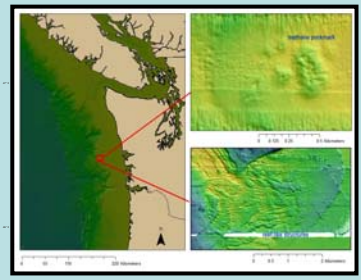
School of Oceanography
University of Washington

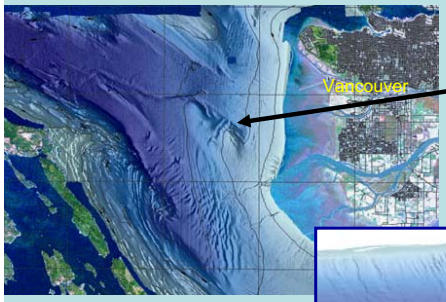




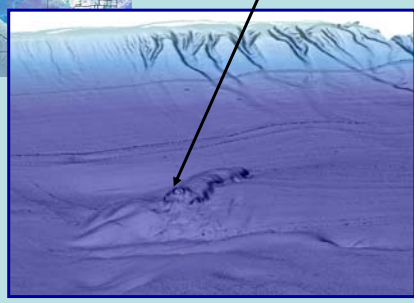
Flattening and truncation of the margin sediments during low sea stands during glacial periods has exposed the folded sediment layers.



Glass Sponges on the Washington Margin



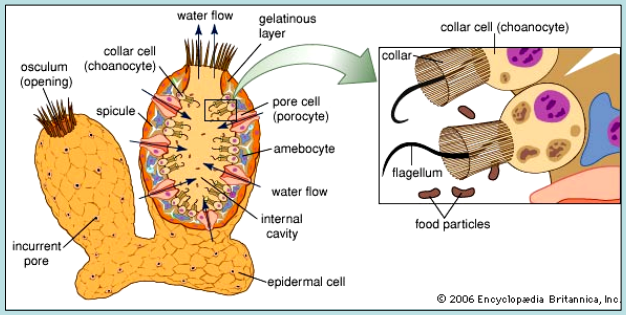
Fraser Ridge Sponge Reef, Strait of Georgia



Glass Sponges

Glass sponge reefs are major nursery areas for rock fish and other commercial species.

How do sponges 'work'?

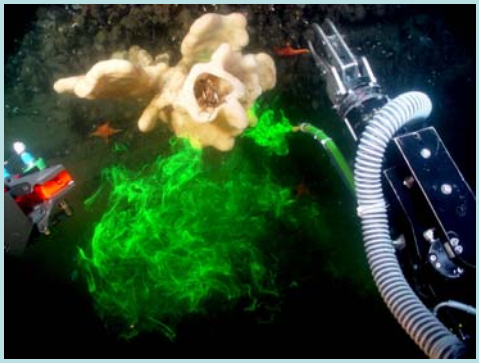


Glass sponges (Hexactinellida) are **NOT multi-cellular animals**.

The soft tissue of each individual glass sponge is a giant multi-nucleate syncytium – i.e., **they are essentially single-celled animals**.

GLASS SPONGES FROM GEORGIA STRAIT REEF CRUISE, 2005
V. TUNNICLIFFE/S.LEYS.

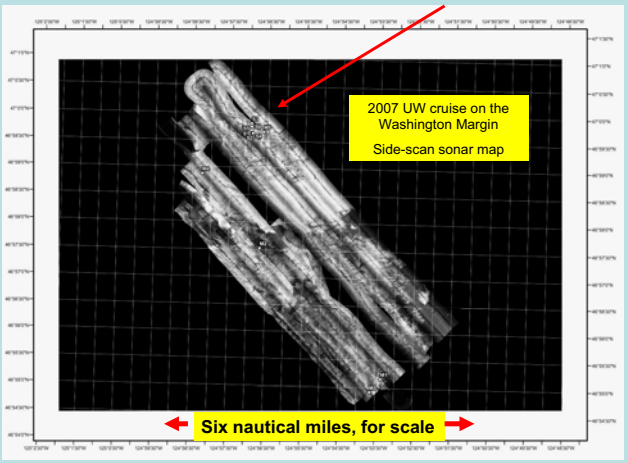
In situ feeding, metabolism, and geochemical fluxes in glass sponges



Sponges look like they are 'just sitting there', but they are actually working quite hard.

They can remove over 50% of the particulate matter from the bottom water, and can change the water chemistry over densely populated reefs.

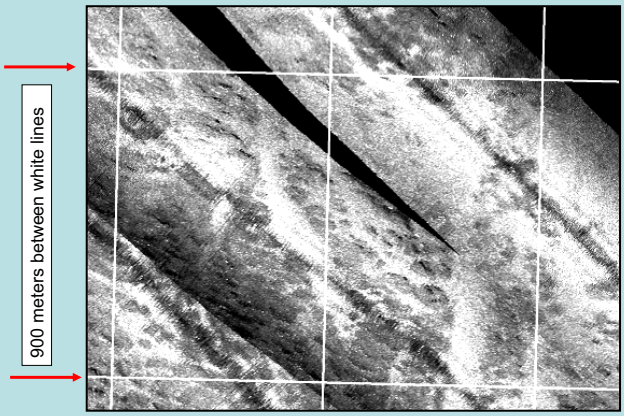
Side-scan sonar image of sponge reef site: dark areas are old reefs. Labels S are sponge sites.



Mound fields in area where we have observed glass sponges.

White areas are hard/flat sand,

Dark areas are (rough/soft reflectors) **reef**



VAN VEEN GRABS CONFIRMED SPONGE LOCATIONS

2008 Sponge Cruise

Sponsored by

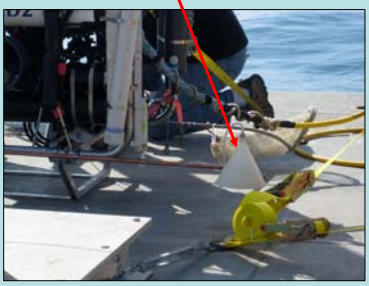
Washington Sea Grant

and The College of Ocean and Fisheries Sciences, UW

Defender Class Catamaran;
58' cruising speed 25 knots.
Crew of 2, scientific party of 5

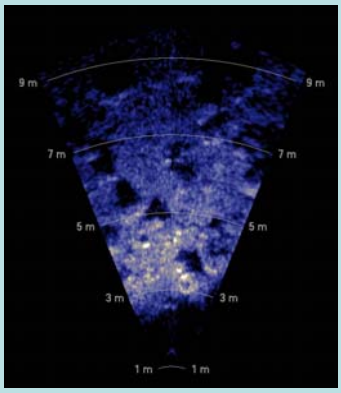
Preparing the ROV in Westport, WA

Bubble Catcher



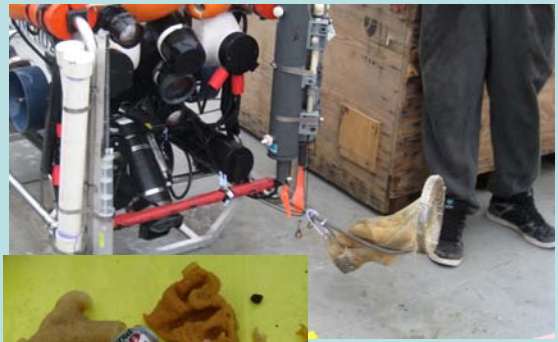
sunny Westport, Washington….

Sample grab, with sponge



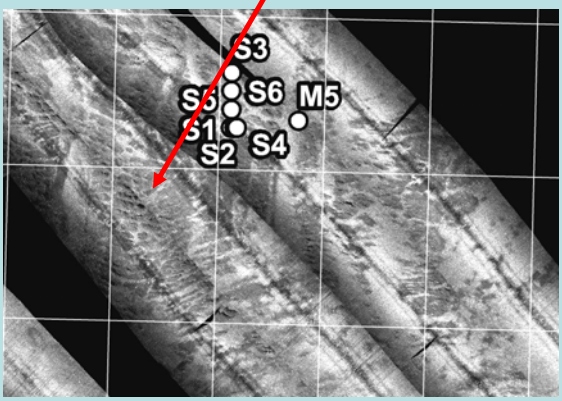
Scanning Sonar image from ROV

Glass sponge sitting on glacial erratic at 160 meters depth on the Washington outer continental shelf.

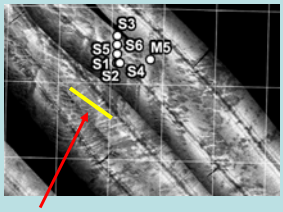


For scale; not product placement (yet).

QUESTION from 2007 cruise – are these scars from fish trawls? Are the reefs being destroyed by the fishing fleet?

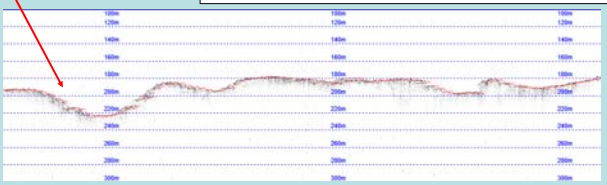


Answer – no, probably not.

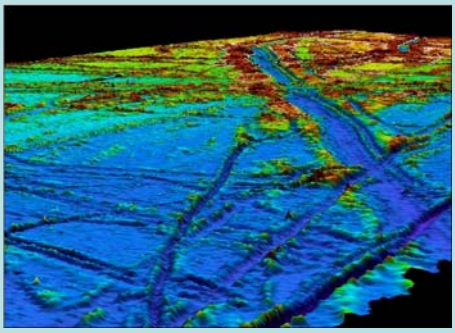


12 khz data over gouges, which contain glacial erratics.

ROV images of glacial erratics in **iceberg gouges**



How does that work?



When you have icebergs that are thicker than the water depth, their movement **gouges trenches** in the margin sediments (or in the existing sponge reefs).

During the **Last Glacial Period**, sea level was about 125 meters below present day sea level. And the depth of the Grays Canyon reefs is only 160 meters.

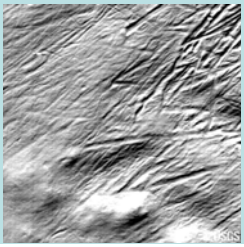
The observation that there are iceberg gouges (from 20,000 years ago) in the glass sponge reefs implies that the Washington Margin Reefs are older than the Last Glacial Maximum (22,000 years BP), and

Sea Level curves (sponges have to live BELOW the photic zone) mean that **our Washington glass sponge reefs are**….

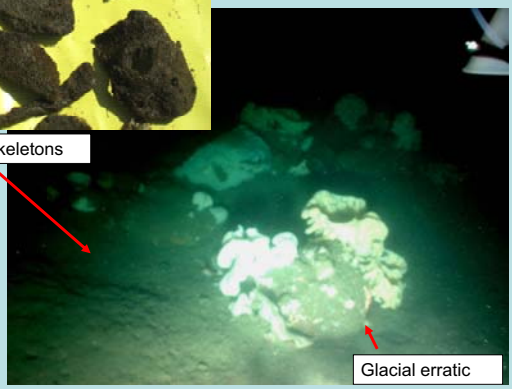
About 80,000 years old.

The oldest known continuous living ecosystem in the ocean.

Iceberg gouges in the Atlantic margin sediments at about the same depth, off New Jersey coast.



Old, dead sponge skeletons



Glacial erratic

So – the Washington margin off-shore of Grays Harbor has large-scale glass sponge reefs.

Which are **nurseries** for rock fish and other commercial species.

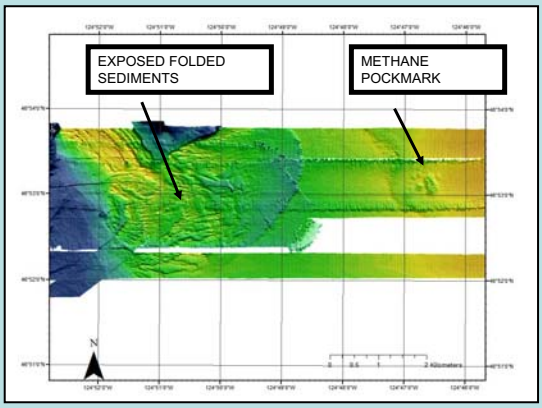
But now, another feature of our margin -

Methane vents, massive krill swarms, and

WHY the Washington margin is such a productive commercial fishing zone

The real 2008 **surprise**.

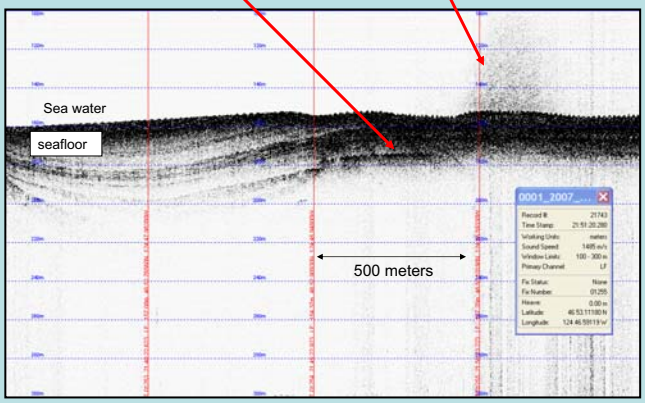
Methane Plumes and Krill Swarms



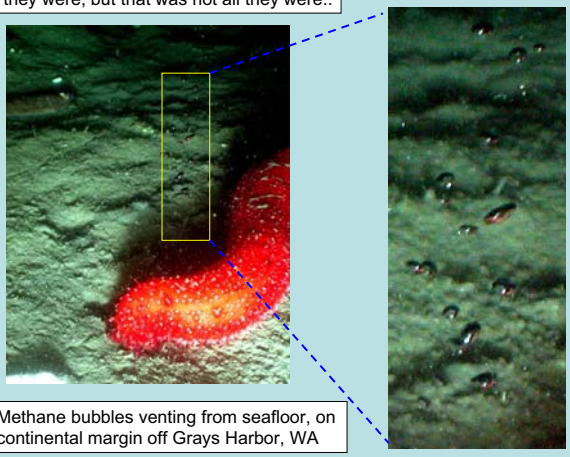
3.5 KHZ PASS OVER POCKMARK, showing structural control of fluid/gas flux

METHANE GAS IN SEDIMENTS

We assumed these were methane bubbles



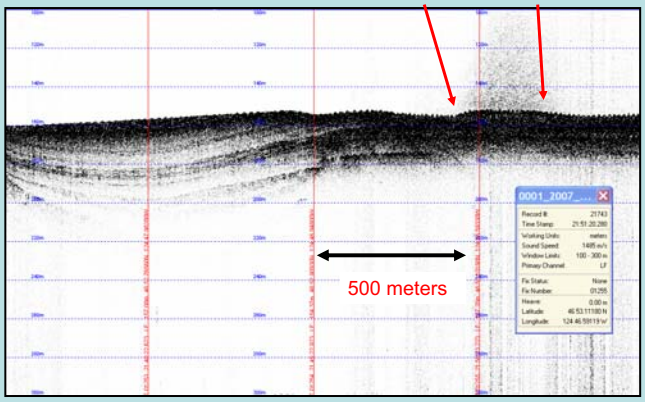
And they were, but that was not all they were..



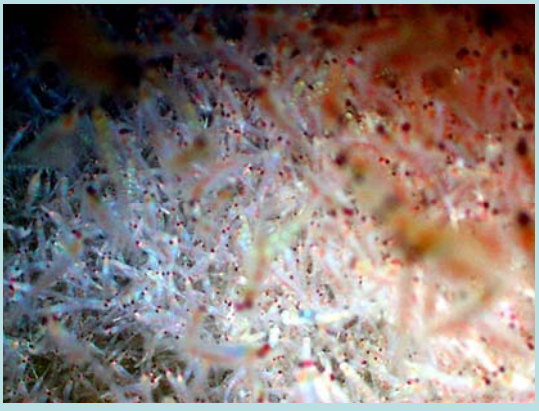
Methane bubbles venting from seafloor, on continental margin off Grays Harbor, WA

On our 4th dive, we took the ROV on a traverse through the acoustic 'fog' overlying the pockmark, expecting to see large methane bubble plumes

We went from here… to here

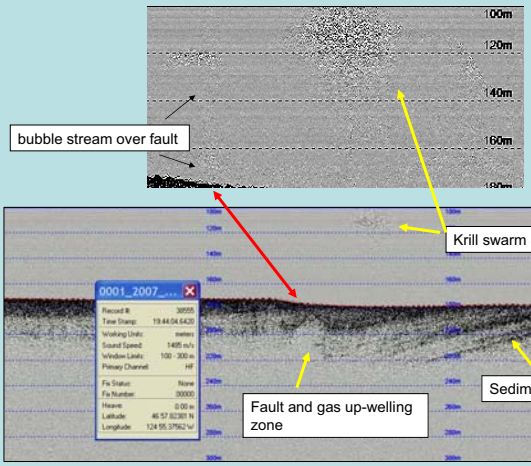


Krill swarm near methane bubble plume



Samples of these annoying animals were identified as Thysanoessa spinifera (J. Keister, pers.comm.)

So now the question is – how common is this phenomena on the Washington margin?

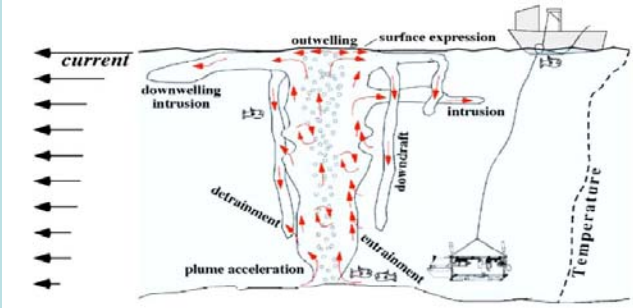


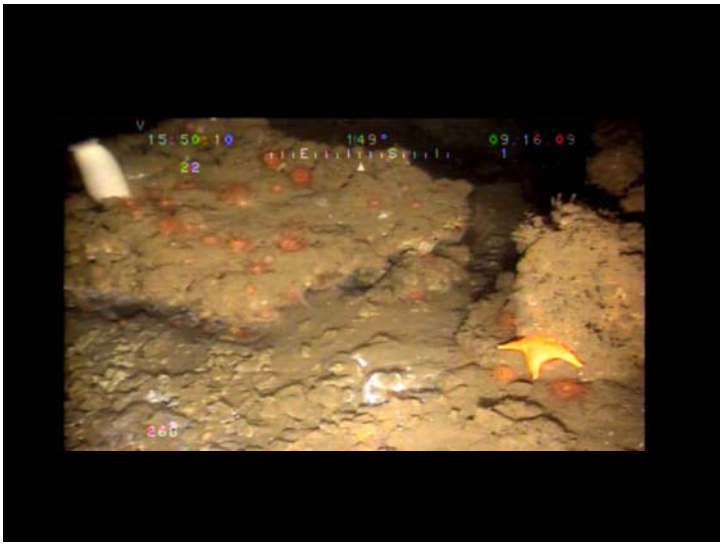
3.5 khz seismic image over methane vent area

Water circulation near a methane bubble plume.

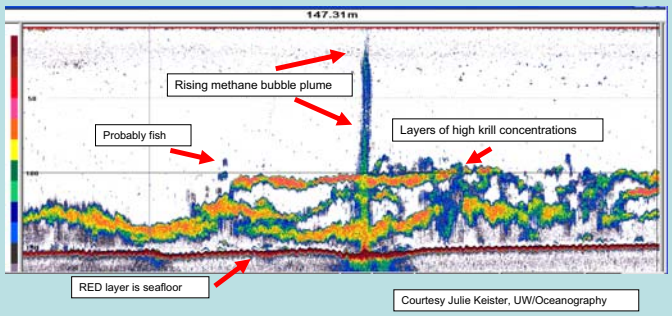
The buoyancy of the bubbles lifts the cold, saline and nutrient-rich bottom water up to the surface.

After release of the bubbles to the atmosphere (as a greenhouse gas), the bottom water descends as a 'reverse' plume, leaving nutrient-rich layers behind in the stratified water column.

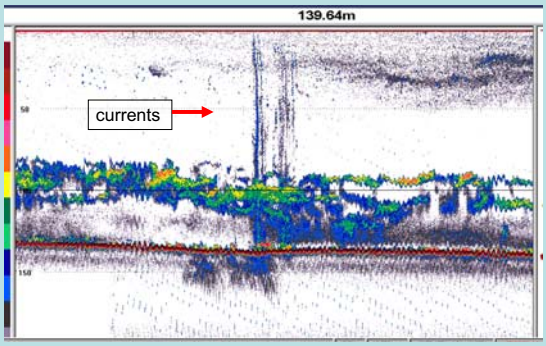




To get the Big Picture of the methane vent area – and it's biology, this year (Sept 2009), we did an acoustic profile over the same methane vent, using a 200 kHz sounder.



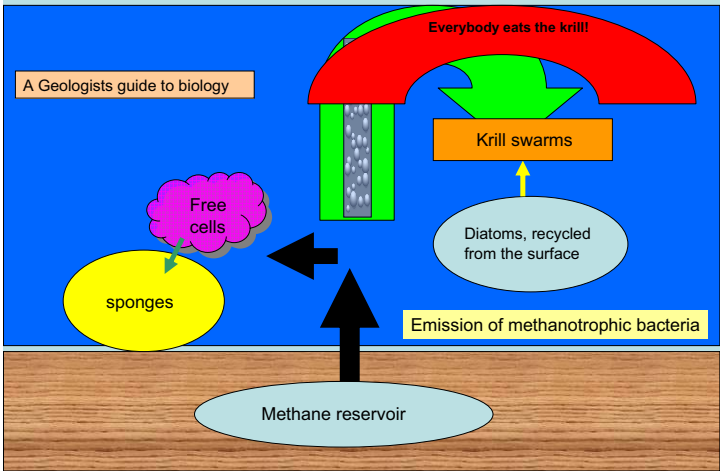
How common are these methane vents on the Washington margin?



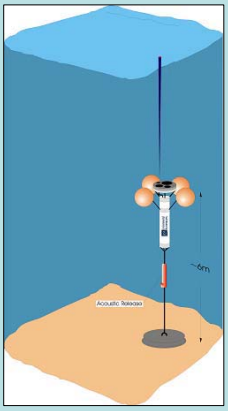
Another methane vent site; approximately 5 miles from the previous site.

Note many individual methane plumes from this site, and that 'downwind' from the plume, the concentration of biology increases dramatically.

Can emissions of methane from the sub-seafloor support a chemosynthetic ecosystem on the Washington margin?



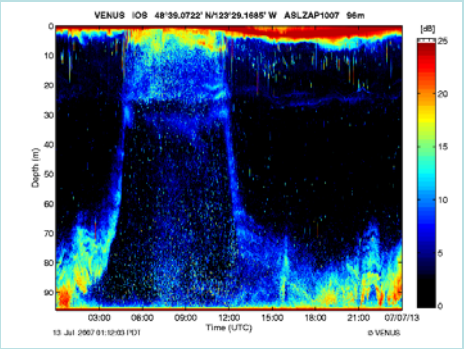
Inverted Echo Sounder from the bottom, looking up.



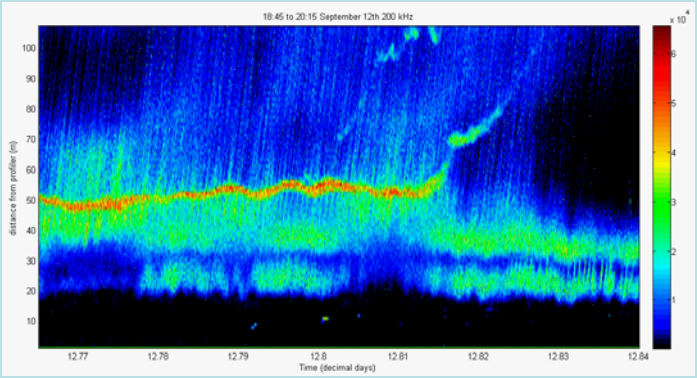
"Normal" krill behaviour, away from methane vents;

UP to surface to feed during the night:

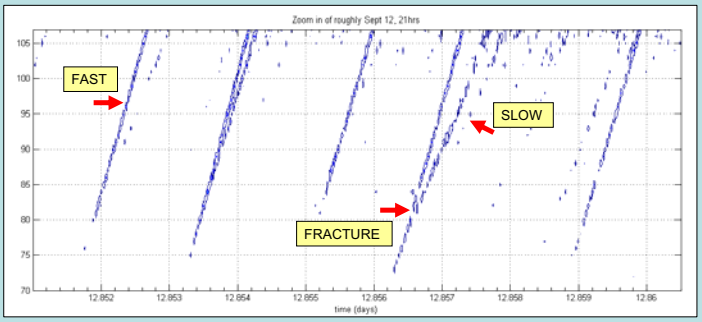
DOWN to bottom to avoid predators during day.



The non-traditional 'RISING' of krill on the Washington margin – in the presence of methane bubble plumes.



NOTICE that only some of the krill rise to the surface at sunset: substantial numbers stay close to the bottom; perhaps because of delivered 'fast food'.

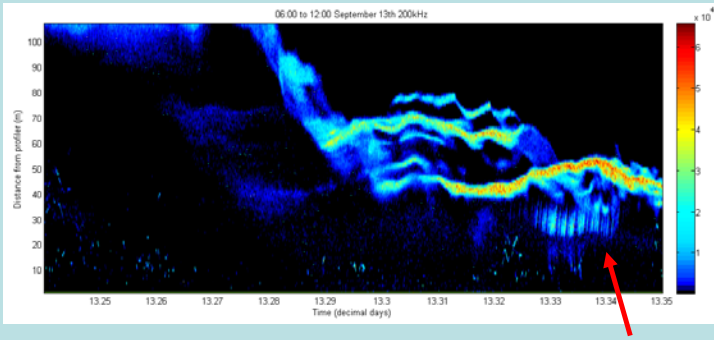


The bottom-mounted sonar can image individual bubble plumes as they rise to the surface, carrying bottom water and krill.

Methane bubbles grow in size to a maximum of about 1 cm, then they oscillate and fracture into smaller bubbles in mid-water.

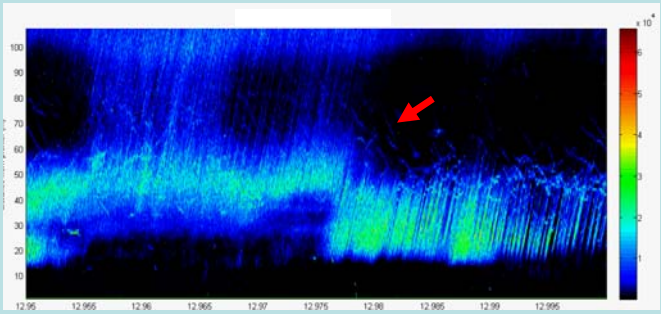
Large bubble plumes rising to the surface can impact the behaviour of seafloor biology – especially krill.

Descent of krill from the surface – at dawn.



Small burst of bubbles, lifting krill layer

LARGE blast of methane bubbles, lifting some of the krill up to the surface, **during the day, when they don't want to be there.**



So they form small groups – and swim back down to safety

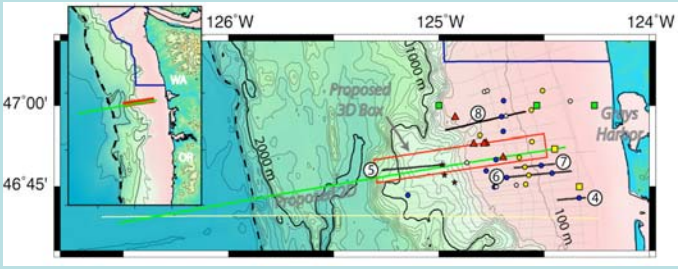
So what is going on – on the Washington margin?

1. There are large reefs of glass sponges, that are nurseries for commercial species of fish. These reefs are very old (+80,000 years).

2. There are many (>20?) sites of methane venting, just in the Grays Canyon area.

3.This methane venting has a dramatic impact on the marine biology of the WA shelf; including
   a. attracting large swarms of krill;
   b. providing a non-seasonal food source for fish;
   c. sustaining the sponge reef nurseries; and
   d. providing carbon for a partially chemosynthetic environment.

Are there many methane plumes on the Washington margin?



Preliminary examination of archive seismic data indicates that there are at least 23 mud diapirs, which are potential methane plumes sites.

We have looked at 4 sites: two are venting methane