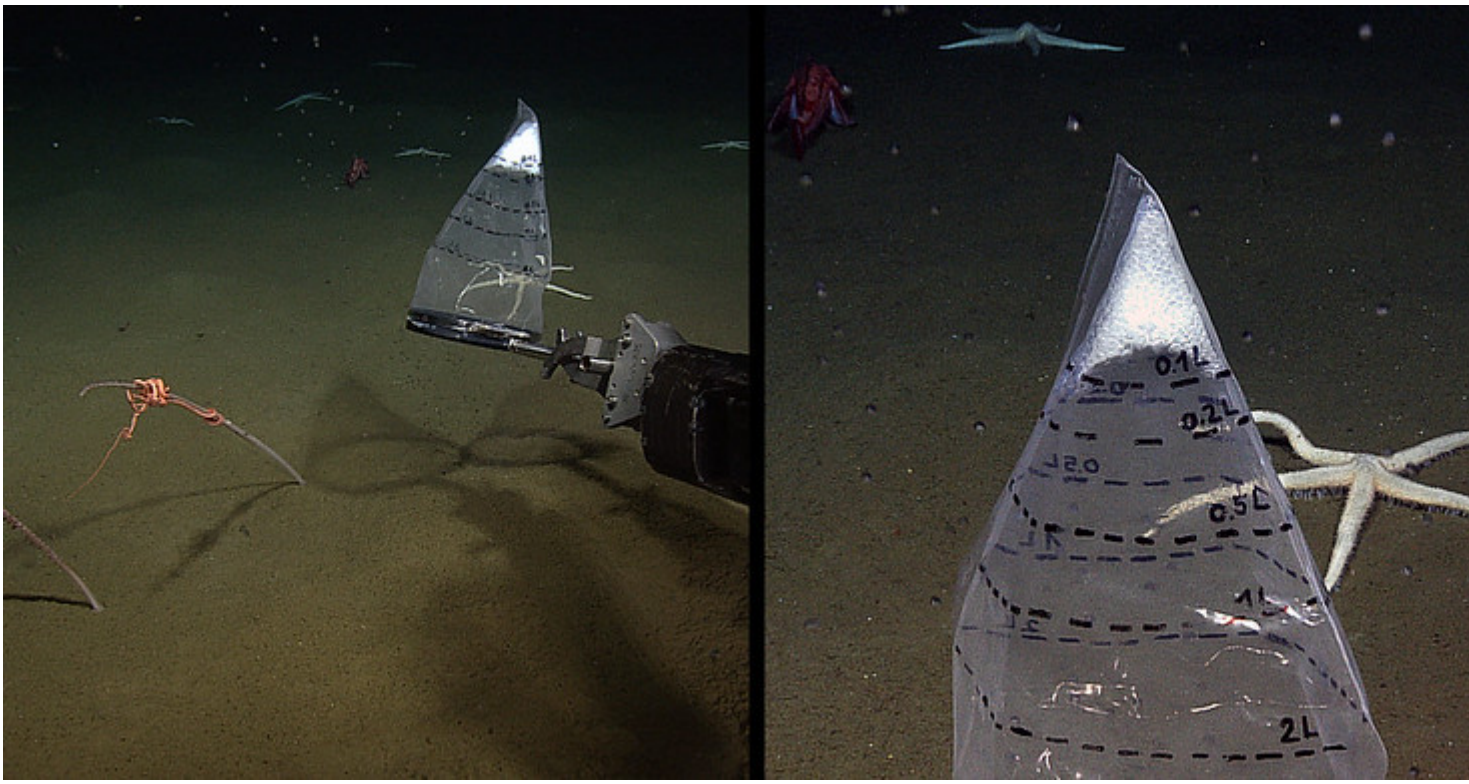
Secret Lives of Submarine Gas Flares

Submitted by Dwight Owens Thu, 2014-07-03 13:24

We know that methane gas bubbles from the seafloor near our Clayoquot Slope study site (depth: 1250 m). But what is the variability of this venting, does it change over time, and what causes flares of methane bubbles to start, stop or shift locations? Where is the bubbling most continuous and where is it most unpredictable? These are questions visiting scientist Dr. Miriam Römer has been trying to answer. Römer, a research scientist with the MARUM Centre for Marine Environmental Sciences at the University of Bremen, spent the past 3 months working with Ocean Networks Canada staff scientists analyzing a large and disparate collection of data from Clayoquot Slope.



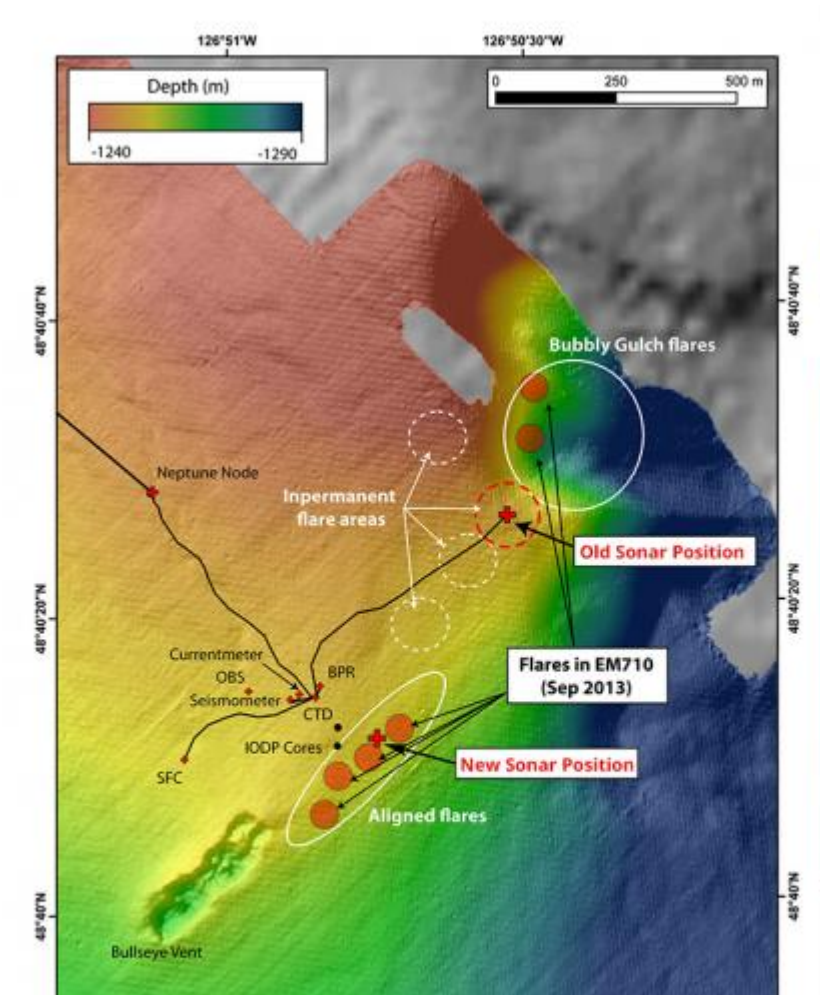
Methane bubbling from the sediments on Clayoquot Slope was collected in a plastic bag in order to quantify rates of methane release from the seafloor in that location, 24 May 2014. These measurements will help Römer work towards the calibration of the sonar data and

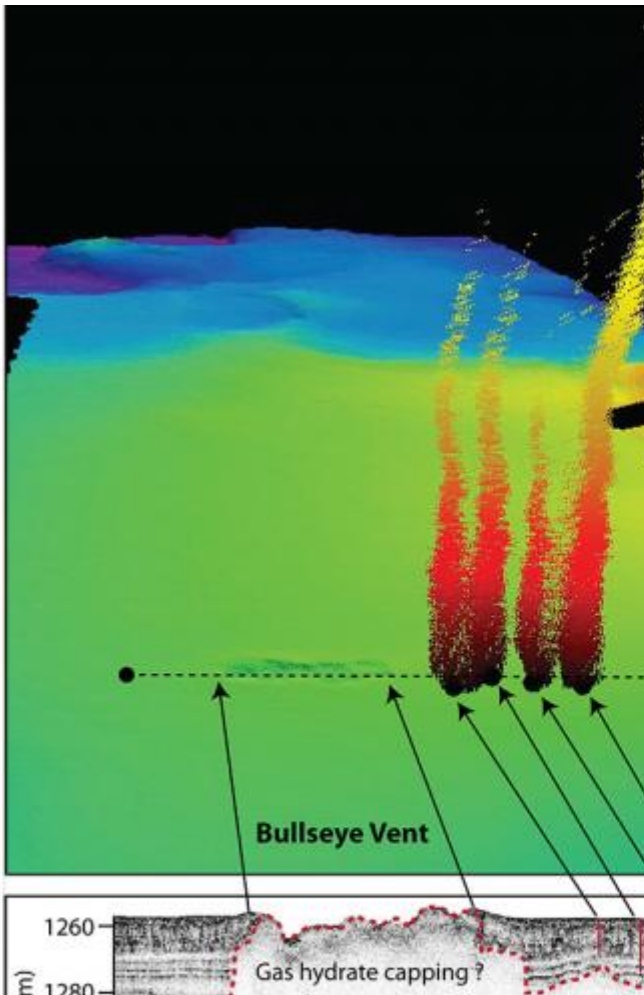
thereby estimate the volume of gas escaping from a much larger area of the seabed.

There are large stores of frozen methane hydrate below the seabed at this site that are releasing streams of methane gas bubbles that migrate up through the sediment and escape into the overlying seawater as bubble streams. These bubble streams are large enough to appear in ship sonars as ?gas flares? (also known as gas plumes) that can rise for several hundred metres above the seafloor. Some of the methane gas released from the seafloor may end up in the atmosphere where it has a greenhouse effect more than 20 times more powerful than that of carbon dioxide for a few decades. Scientists are therefore very interested in being able to estimate the total amount of methane that is escaping from the seafloor on continental margins around the world, and in understanding what controls the rate of gas release.

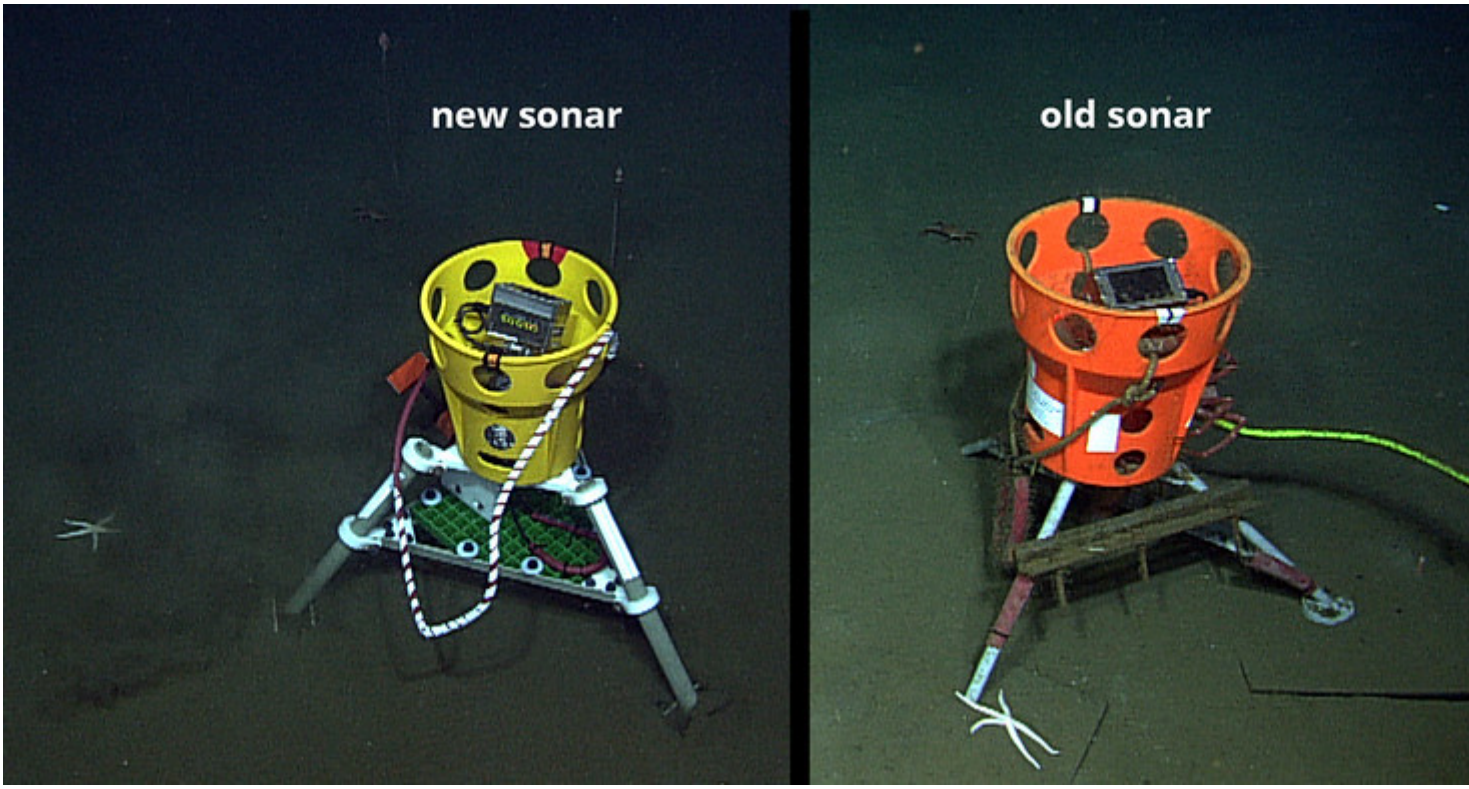
Mapping Gas Flares

Römer's first task was to map source locations for methane gas flares bubbling from the seabed. Integrating ship-based echosounder data with data collected by sonars mounted on remotely operated vehicles and installed on the NEPTUNE Observatory network, Römer was able to identify the two main source areas for the flares. The first is an area known as Bubbly Gulch, close to where an Ocean Networks Canada sonar has been deployed since 2010. A second area of flares, now dubbed 'Gastown Alley', is located along a line stretching northeastward from the Bullseye Vent gas hydrate formation. These two areas have been showing more permanent venting activity. However, Römer's analysis of the sonar data from just southwest of Bubbly Gulch found the gas emissions at the sonar site are more intermittent. These findings helped scientists choose a new deployment location for the Clayoquot Slope sonar, between two high-volume flares along the Gastown Alley line fracture zone northeast of Bullseye Vent. (A replacement sonar was deployed in this location during the May 2014 expedition.)





Map and visualization of gas flare locations between Bullseye Vent and Bubbly Gulch. The map at the left shows former and current sonar positions in relation to gas flares (red circles) in Bubbly Gulch and along a line norheast of Bullseye Vent. The visualization at upper-right shows the vertical extent of gas flares above Bubbly Gulch and Gastown Alley. The sub-bottom vertical cross-section, lower-right, shows areas of gas hydrate capping beneath Bullseye Vent, a fracture zone and region of high gas content beneath Gastown Alley, and areas of diffuse gas and gas-rich sediments beneath Bubbly Gulch. Maps and visualizations prepared by Miriam Römer. Sub-bottom profile and bathymetry courtesy of Monterey Bay Aquarium Research Institute.



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Replacement of the multibeam sonar at Clayoquot Slope, 24 May 2014. Scientists use this sonar to study plumes of methane bubbles escaping from the seafloor in this area.

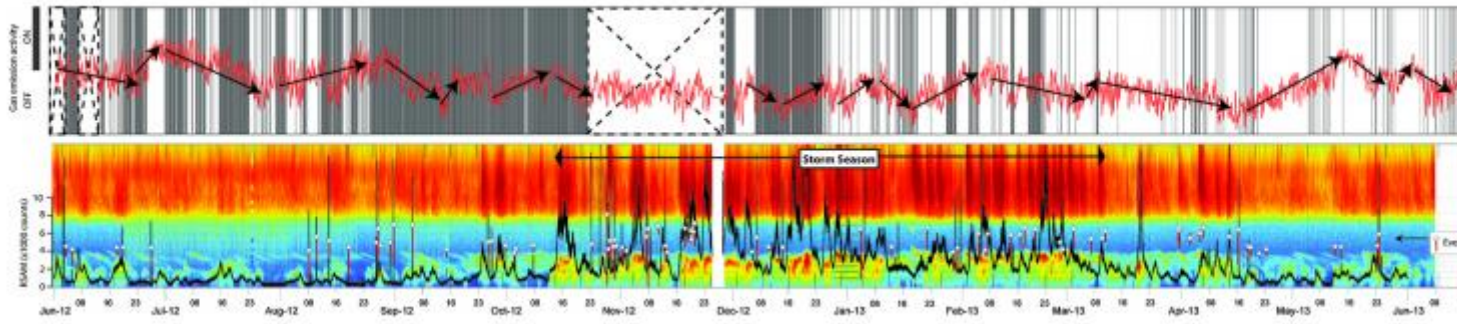
Probing 4 Billion Data Points to Understand Flare Variability

Having mapped locations of gas flares, Römer next sought to understand causes for their variability. Are fluctuations primarily related to changes in currents, storm events, earthquakes, tides or other factors? This investigation involved analysis of large amounts of data, including:

- Imagenex sonar scans
- Current meter velocities
- Seafloor pressure measurements
- Seismometer data and earthquake events
- Buoy wave height data

- Temperature measurements

Römer combined these disparate data into a remarkable plot that shows gas emission activitiy, temperature fluctuations, storms and wave heights, earthquake events and ground motion variability over 13 months between June 2012 and July 2013. This plot reveals roughly 3 phases of gas emission activity, including an initial 3 months of quite variable flaring, 4 months of nearly continuous flaring, and a final 6 months of intermittent flaring. She found no correlations between gas flaring and the storm season or week- to month-long temperature trends. She also detected no correlation with earthquakes or ground shaking events.



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13-month time series showing gas emission activity (grey bars), temperatures (red) and temperature trends (black arrows), storm intensity (coloured bottom pressure spectra plot at bottom), earthquake events (small white stars with red lines), and ground shaking intensity (also referred to as 'realtime seismic amplitude measurement' or RSAM, shown as the black line on the lower plot) - a plot combining over four billion data points!

What Römer did find is that the intensity of gas emissions is correlated with tidal cycles. Examining several data segments in detail, she found that gas release is triggered at low tide, when the pressure of the overlying ocean on the seabed is lowest. She suggested that free gas might be accumulating in a subsurface reservoir during high tides, and then escaping as water pressure decreases below a certain threshold.

Fruitful Collaboration

Römer first learned of Ocean Networks Canada about a year ago. Her initial contact with Ocean Networks Canada staff scientists blossomed into a fruitful collaboration. About her visit, Römer commented that it was very interesting to learn how "people are making [Ocean Networks Canada's facility] work in the background," behind the data. For her, one of the most exciting aspects of her work here was seeing and working with high-resolution time series data, which allowed her to "plot the data and see the correlations." She said that without the cabled observatory, this long term monitoring and comprehensive data correlation could not be achieved.

These results will help her upcoming research missions now that she understands the influence of the tidal cycle. In the future, Römer intends to monitor and analyze data from the new sonar position, using new methods for mapping sources. "Determining the strength of individual flares" will be a difficult challenge, she thinks. She also hopes to return to the Cascadia Margin and Clayoquot Slope aboard a German reserach vessel, to carry out more

detailed studies of gas emissions in this dynamic and unusual environment.

Dr. Miriam Römer works with some very "cool" projects aboard a marine research vessel.

For Ocean Networks Canada staff scientists Martin Scherwath and Martin Heesemann, Römer's visit was tremendously helpful, too. "We've gained hands-on knowledge about the researcher's needs for data products and data access. Additionally, we have improved this specific gas hydrate experiment," Scherwath commented, "and we hope for a continued fruitful future engagement in the future."

Ocean Networks Canada encourages other researchers to contact us and visit the facility for an extended stay, as much can be learned by all sides.

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about gas hydrates research.

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