# Dynamics of Hydrocarbon Vents: Focus on Primary Porosity


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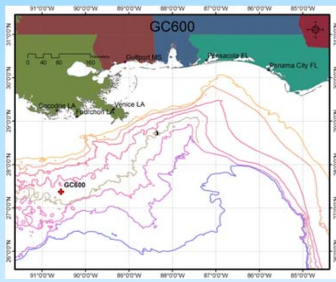
**Objectives:**

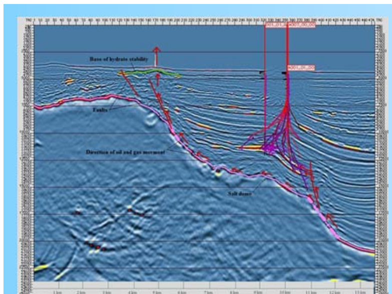
I am looking at the variability of natural hydrocarbon seeps at GC600, which is an ECOGIG long term study site. My main Objectives are to:

1. **Quantify the frequency and volume of bubble release.**
2. **Determine whether there is cyclic variation in bubble release rates.**

My results were obtained from two separate camera deployments:

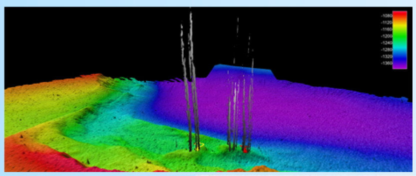
- The first on November 2010 during a cruise with ALVIN where Still frame time-lapse images were taking 1 image every 4 sec. for ~3hrs
- The second on November 2012 with the research ship Falkor where Video time-lapse clips were recording 16 sec. of video every 5 min for ~60hrs, which is approx. 2.5days

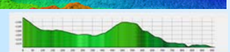


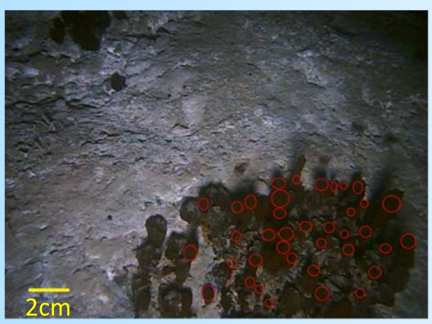
This swath mapping data collected by the RV FALKOR, shows a composite of bubble plumes in the water column. These plumes are found to correspond with the NW to SE direction as seen in the seismic cross section.

There are two distinct seep areas which we have named. The Birthday candles, which is where the first camera deployment was (A); and the Mega-Plume, which is where the second camera was deployed (B). The distance between the two camera deployment sites is ~950m.





This is a seismic cross section through the GC600 seep site from the NW on the left to the SE on the right. The dominant structure is the salt diapir. The source of the hydrocarbons is presumably to the SE of the cross section. The hydrocarbons are thought to migrate up along the flanks of the salt diapir and then through a series of faults to the sea floor.

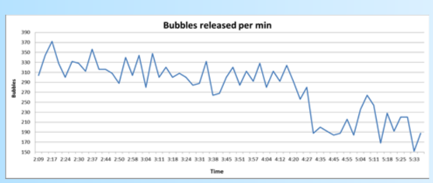

This is an image of the first site, Nov. 2010. The camera was deployed very close to the seep for ~3hrs and took a still image every 4 seconds.

At this seep, we saw oily bubbles being released through an exposed portion of hydrate that was approximately 8x15 cm.

When I examined the photographs, I found that the very oily bubbles were escaping from discrete points that did not change throughout the 3 hours of observation.

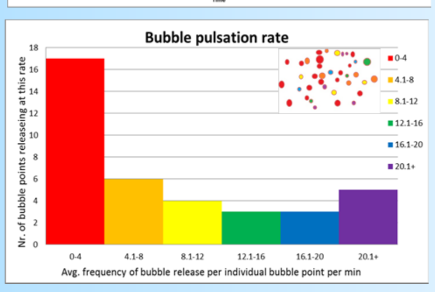
To analyze the release rates, I mapped where the release points were and assigned each one a number. Then I counted, frame by frame, the release of bubbles from each individual point.

I analyzed 1 min worth of images for every 3rd min of the total collection. The line graph depicts the total release per min from the seep. Overall the average release of bubbles is 278 bubbles/min (stdev. 54.9).



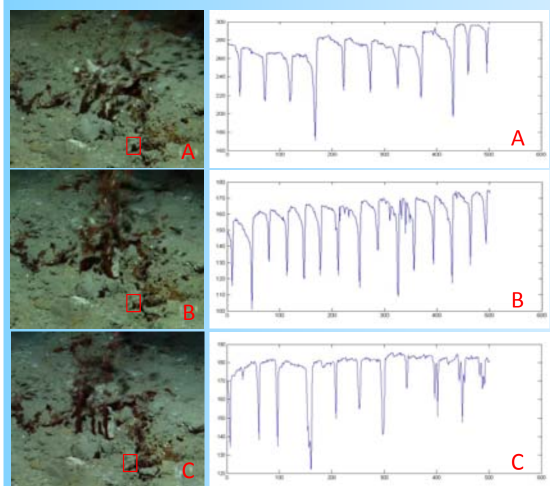

The histogram of bubble pulsation rates shows that the points tended to release bubbles at different rates. The frequency distribution is skewed toward release rates of approx. 4 bubbles per min, with a maximum speed of 20 bubbles/min and an average of 7.4 bubbles/min (stdev. 1.42).

In the insert, the release points are color coded in relation to their frequency. The spatial distribution does not indicate a clear pattern rapid or slow release. There is no indication of a fault or channel that would cause locally higher rates of discharge.




The 2[nd] camera deployment was in Nov. 2012 with the Global Explorer ROV deployed from the RV FALKOR. Video clips of 16 sec. were taken every 5 min for about 2.5 days. Our second deployment, was in the Mega-Plume area, which is a much more active and gassy vent compared to the first one. I am currently in the process of developing methods for quantifying the release rates and release magnitudes for this much larger image set.

Below I show some preliminary data. I used a simple image processing technique to count the bubble releases at one bubble point throughout a 16 second clip. This technique will not be applicable to each bubble point in the data set, therefore new methods are being developed.



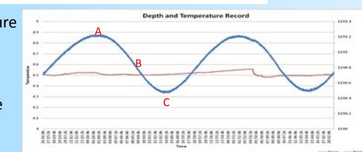

At time A ~0.69 bubbles/sec

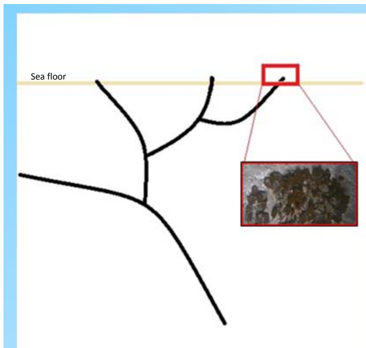
At time B ~0.94 bubbles/sec

At time C ~0.69 bubbles/sec

This graph of the depth and temperature record shows that there is a clear tidal signal of about 0.72m.

With further analysis of my new data set, I hope to test whether release rate variations are correlated with the tidal signal.




I am attempting to form a model to help us better understand the possible migration pathways using fractals.

Under the constraints of Euclidean geometry, we can grossly approximate the shape of objects in nature. Fractal patterns can arise from a variety of non-linear dynamical systems.

Assuming the fractal geometry of migration patterns from the reservoir to the sea floor seeps is driven by porosity; I want to attempt to quantify the network of faults through the different levels of porosity.

The individual bubble points that I have been quantifying represent the leading edge of the large scale process of natural hydrocarbon seepage in the Gulf of Mexico.

I propose a conceptual model describing the process of oil and gas migration from the macro to micro scale through different levels of porosity.

- The first level being, what I have come to consider, as a bundle of tubes passing through the gas hydrate.
- The second level of porosity the pathway that generates individual vents like the birthday candles and Mega-Plume.
- And this next level is the pathway along the faults.

Better understanding of the seep plumbing should provide insight into the differences among separate seep sites, and of the way seep formations develop over time.