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GULF OF MEXICO RESEARCH INITIATIVE

GoMRI Theme 1

Resuspension, Redistribution and Deposition of Deep Water Horizon Recalcitrant Hydrocarbons to offshore Depocenters

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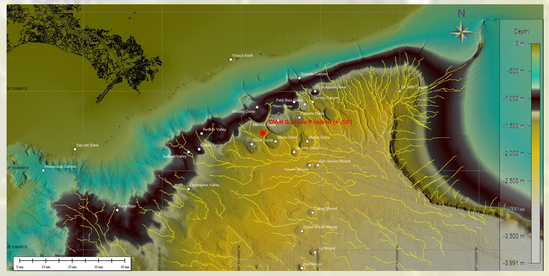
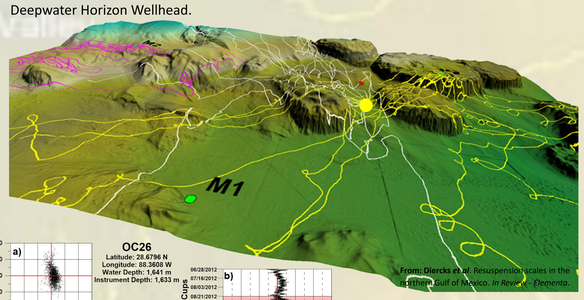
Abstract: The research team proposes a geospatial, sedimentological, and geochemical approach to study the fate of the Deepwater Horizon (DwH) marine oil snow (MOS) deposited during the Marine Oil Snow Sedimentation and Flocculent Accumulation (MOSSFA) event on the seafloor in offshore waters of the Gulf of Mexico (GoM). The central hypothesis of the proposed research is that recalcitrant compounds from the deposited oil still remain on the seafloor ~7 years after the DwH spill, however, their spatial distribution and concentration do not correspond with the distribution of the surface oil slick or the subsurface plume due to resuspension and redistribution following initial deposition on the seafloor. Natural heterogeneity of bottom topography and circulation processes are key drivers transporting materials to deeper areas in the GoM by erosion and deposition of contaminated sediments beyond the surface extent of the once existing oil slick or the subsurface plumes(s). The results obtained in this effort will elucidate the fate of the oil released during the DwH oil spill, which is important for developing new mitigation strategies for future submerged spills in the GoM and worldwide. The seafloor depositional environment is highly diverse, which should result in a non-homogeneous distribution of material delivered from the overlying water column. Seafloor sedimentation is affected by currents, bottom morphology, and physical forcing events of different temporal and spatial scales that rework deposited material within the Bottom Nepheloid Layer (BNL).

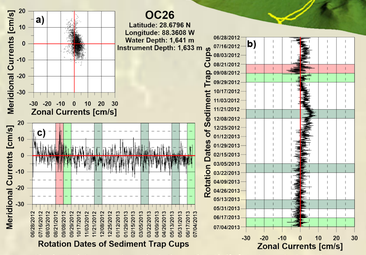


Bathymetry from NOAA vessel Okeanos Explorer (50m/pixel) and the **General Bathymetric Chart of the Oceans** (GEBCO; http://www.gebco.net/) (3 arc sec/pixel). Yellow lines are modeled drainage paths and depend strongly on the resolution of the available bathymetry for flow prediction. Red star indicates position of the Macondo Deepwater Horizon Wellhead.



From: Diercks et al. Resuspension scales in the northern Gulf of Mexico. *In Review - Elementa.*

Block Diagram of seafloor around DWH (red dot). Block Diagram of seafloor topography in the vicinity of Macondo Well with current meter data overlain as vector addition. Presenting the potential source areas for resuspended material collected in a sediment trap and imaged by the flux camera deployed approximately 5km south of the Macondo well (yellow dot). Lines represent 18 days of current meter measurements. Currents are plotted as flow towards the mooring, presenting the flow in relation to the diverse morphology of the area potentially supplying material to the trap samples.



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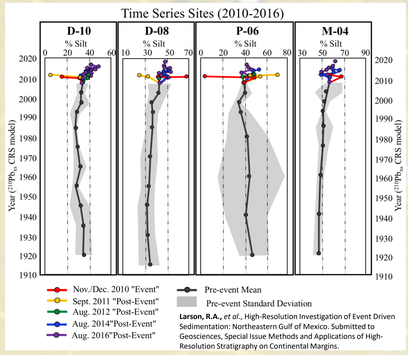
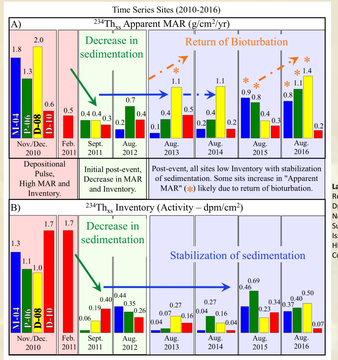
Time Series of current data (~14mab) of the upward looking ADCP in the trap mooring.



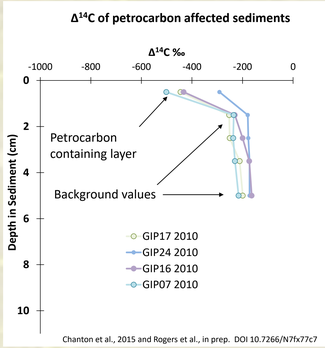
Larson, R.A., et al., High-Resolution Investigation of Event Driven Sedimentation: Northeastern Gulf of Mexico. Submitted to Geosciences, Special Issue Methods and Applications of High-Resolution Stratigraphy on Continental Margins.

Figure shows a significant deviation in grain size immediately following the DwH event, and gradual relaxation in the following years to near pre-event (down-core) values. Also note the good reproducibility of down-core values. Much has been said about spatial heterogeneity....but we don't believe that this is a big issue from a sedimentological standpoint.



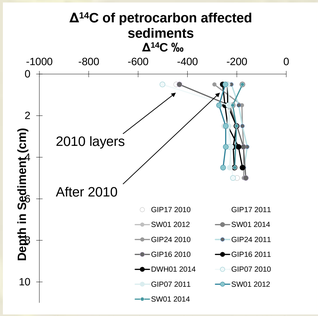
Larson, R.A., et al., High-Resolution Investigation of Event Driven Sedimentation: Northeastern Gulf of Mexico. Submitted to Geosciences, Special Issue Methods and Applications of High-Resolution Stratigraphy on Continental Margins.

An initial sediment pulse after the DwH can be seen as an increase in mass accumulation rates (MAR), supported by high ^{234}Th inventories. Both drop off rapidly (within ~1 year) reflecting a rapid and significant decrease in sedimentation rate. The "apparent" increase in MAR at some sites as early as 2013 is not real as it is not supported by inventory data. Rather it likely reflects the return of bioturbation (at some sites) that mixes the ^{234}Th downward, resulting in an "apparent" increase in MAR.



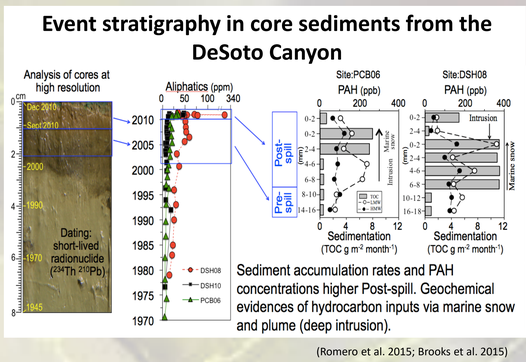
Chanton et al., 2015 and Rogers et al., in prep. DOI 10.7266/N7fx77c7

Our time series indicates a rapid return of surface sediments to background radiocarbon values, consistent with the hypothesis that the surface petrocarbon containing layer was suspended and sloughed off to deeper waters.



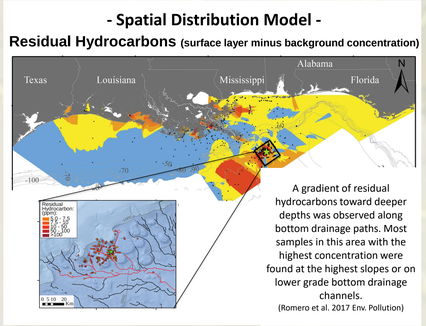
Chanton et al., 2015 and Rogers et al., in prep. DOI 10.7266/N7fx77c7

Look for petrocarbon that has been resuspended and transported to deeper water → downhill. Based on our preliminary data, some of it its no longer where it used to be.



(Romero et al. 2015; Brooks et al. 2015)

In previous work, we combined sedimentological and geochemical analysis to elucidate the sediment layers that were deposited before and after the DWH spill in the DeSoto Canyon. Higher sedimentation rates and geochemical signatures for MOSSFA and the deep plume were observed in the top cm of the cores collected in December of 2010.



We did the same analyses on a larger scale (194,000 km²) comparing the sediment layer deposited after the spill (surface, top 1 cm) with the layer deposited before the spill (background, >1 cm depth in the cores) using data available online to generate a map of deposition of weathered oil on the seafloor of the GoM after the spill. Specifically for the deep-sea area, we found that deposition of hydrocarbons was greater (higher concentration of residual hydrocarbons) toward deeper depths along bottom drainage paths.

We hypothesize that the area of seafloor that was affected by deposition of oil from the spill is larger than the area of the surface slick extending into "downhill" areas on the seafloor (>1,500m). Through down-gradient transport, material will follow pathways based on the highly variable seafloor morphology, with its hills, slopes and canyons, allowing for erosion and deposition beyond the spatial extent of the once existing oil slick or subsurface plumes(s), and beyond the distributions mapped in the year following the spill, thus potentially affecting an area much larger than originally described and has been sampled to date.

Has the seafloor petrocarbon been degraded? Or resuspended and advected? Lets look downhill!