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Macondo–1 Well Oil in Sediment and Tarballs from the Northern Gulf of Mexico Shoreline

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Summary

From April 20 through July 15, 2010, an estimated 4.4 million barrels (1 barrel = 42 gallons [~700,000 cu m]) of crude oil spilled into the northern Gulf of Mexico (nGOM) from the ruptured British Petroleum (BP) Macondo–1 (M–1) well after the explosion of the drilling platform Deepwater Horizon (Crone and Tolstoy, 2010). In addition, ~1.84 million gallons (~7,000 cu m) of hydrocarbon-based Corexit dispersants were applied to the oil both on and below the sea surface (Operational Science Advisory Team, 2010). An estimate of the total extent of the surface oil slick, derived from wind, ocean currents, aerial photography, and satellite imagery, was 68,000 square miles (~180,000 sq km; Amos and Norse, 2010). Spilled oil from this event impacted sensitive habitat along the shores of the nGOM.

In response to this environmental catastrophe, the U.S. Geological Survey (USGS) collected coastal sediment and tarball samples along the shores of the nGOM from Texas to Florida before and after oil made landfall. These sites included priority areas of the nGOM at highest risk for oil contamination. These areas included coastal wetlands, shorelines, and barrier islands that could suffer severe environmental damage if a significant amount of oil came ashore.

Samples were collected before oil reached land from 69 sites; 49 were revisited to collect samples after oil landfall. This poster focuses on the samples from locations that were sampled on both occasions. The USGS samples and one M–1 well-oil sample provided by BP were analyzed for a suite of diagnostic geochemical biomarkers. Aided by multivariate statistical analysis, the M–1 well oil was not detected in the samples collected before landfall but have been identified in sediment and tarballs collected from Louisiana, Alabama, Mississippi, and Florida after landfall. None of the sediment hydrocarbon extracts from Texas correlated with the M–1 well oil. Oil-impacted sediment is confined to the shoreline adjacent to the cumulative oil slick of the Deepwater Horizon oil spill and no impact was observed outside of this area (Rosenbauer and others, 2010, 2011). Incorporation of the analytical data in geographical information systems (GIS) offers querying capabilities and visualizations such as those demonstrated here.

Acknowledgments

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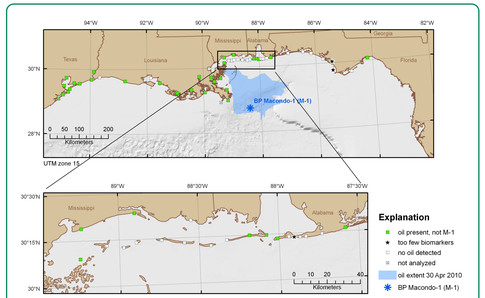

Figure 1. Map showing locations of shoreline sediment samples that were collected both before (May 2010) and after (October 2010) local landfall of BP oil. Biomarker analysis of samples collected before landfall: green squares, detectable oil, shows that none of these samples was related to BP Macondo–1 oil; white squares, oil was not detected; two samples had too few biomarkers to provide identification; and one sample bottle (not analyzed) was broken in transit. The blue shading depicts the cumulative areal coverage of the BP M–1 well-oil spill as of April 30, 2010 (National Oceanic and Atmospheric Administration, 2010).

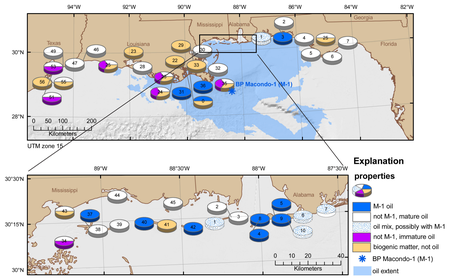

Figure 2. Map indicating the approximate geochemical composition of the extracted organic matter of samples collected after M–1 oil made landfall across the Gulf of Mexico. The gulf is affected by a significant quantity and variety of natural oil seepage. As a result, both thermally immature and mature oil residues, likely from natural seepage, can be detected in some samples.

A blue pie marker indicates sediment containing oil that correlates with M–1 well oil; a white marker indicates sediment containing mature oil that does not correlate with M–1 well oil; a purple marker indicates sediment containing immature oil and (or) biogenic material that does not correlate with M–1 well oil; and an orange marker indicates terrigenous material. Pie markers with a combination of colors are not intended to indicate proportion but rather to indicate that the sediment contains a mixture of components. The pie diagrams are offset from the sample locations for clarity. See figure 1 for sample locations.

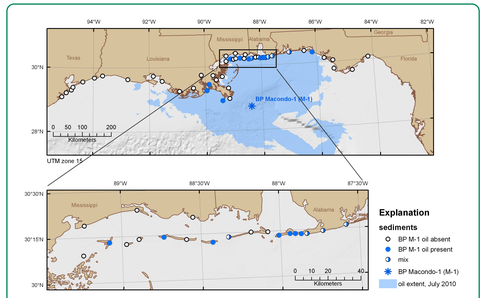

Figure 3. Map showing location of sediment samples collected after oil landfall that correlate with M–1 well oil. Correlated M–1 oil is indicated with a blue-filled circle; uncorrelated oil with an open circle; and a likely mixture of oils (possibly but not verifiably including M–1 well oil) with a half-filled circle.

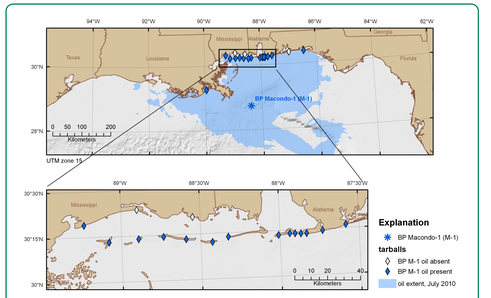

Figure 4. Map showing locations of tarball samples collected in October 2010 after oil landfall that correlate with M–1 well oil. Correlated M–1 tarballs are indicated with a blue-filled diamond; uncorrelated tarballs with an open diamond.

GIS tools organize and visualize critical analytical data.

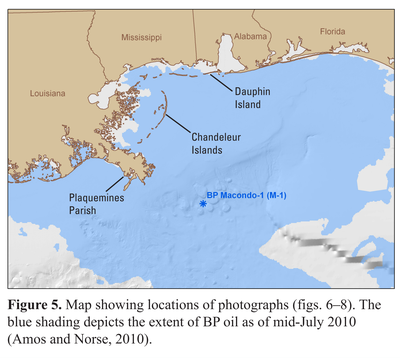

Figure 5. Map showing locations of photographs (figs. 6–8). The blue shading depicts the extent of BP oil as of mid-July 2010 (Amos and Norse, 2010).

Figure 6. Photograph of oil from the Deepwater Horizon oil spill floating on the surface of the water in Bay Jimmy in Plaquemines Parish, Louisiana, June 2010. Booms were emplaced in an attempt to keep the oil out of the marshes. See figure 5 for photo location. (AP Photo, Gerald Herbert, http://www.cbsnews.com/stories/2010/06/29/tech/main6629462.shtml)

Figure 7. Photograph of oil stranded on the north Chandeleur Islands on May 8, 2010. Four areas with this kind of oiling were 100–300 m (300–900 ft) long by 0.5–2 m (1.5–6 ft) wide, with 25–90 percent distribution of oil <1 cm (0.5 in) thick. Three of the four areas were on the north sides of the inlets between the islands. See figure 5 for photo location. (Photo from NOAA, http://www.noaa.gov/deepwaterhorizon/video/oceanservice/deepwaterhorizon/images/chandeleur_island_b.jpg)

Figure 8. Photograph showing tarball found on the beach on Dauphin Island, Alabama, in May 2010. See figure 5 for photo location. (Photo from NOAA, http://oceanservice.noaa.gov/deepwaterhorizon/images/dauphinisland3_b.jpg)

Digital files available at http://pubs.usgs.gov/of/2011/1164/

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