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Progress Report 1

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Assessment of Initial Beach Oiling along Alabama and North Florida Coastline June 7 through June 9, 2010

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Introduction

The Coastal Research Laboratory at the University of South Florida received a RAPID Response Research Award jointly funded by the National Science Foundation’s Sedimentary Geology and Paleobiology Program and Marine Geology and Geophysics Program. The research project is entitled “Emergency Field Investigation of Oil-Beach Interaction along the Alabama and Florida Beaches Following the BP Deepwater Horizon Oil Spill”. The overall goals of the study are: 1) to investigate the patterns of cross-shore distribution of oil-sand mixing; 2) to examine the factors controlling oil and sand mixing within various parts of the beach environment; 3) to document regional characteristics of oil-sand mixing on beaches through a comparative analysis at various study sites; and 4) to establish an improved set of
criteria for assessing oil contamination in a sandy beach environment. In the following discussion, the term “beach oiling” is used to refer to the direct deposition of oil on the sandy beach.

Pre-beach-oiling baseline data collections along the Alabama and north Florida beaches were conducted from May 7th through May 19th, 2010. Beach profiles, surface sediment samples, and short sediment cores were collected at 17 locations to characterize the beach morphology and sedimentology prior to oil contamination. The initial significant beach oiling along the studied coastline resulting from the BP Deepwater Horizon oil spill occurred on June 3rd, 2010. An assessment study by the Coastal Research Laboratory at the University of South Florida was conducted from June 7th through June 9th, 2010. This report summarizes the progressive findings from the baseline data analysis and the field investigation of the initial beach oiling. It is worth noting that the extent and intensity of the beach oiling evolve rapidly with time. The results from this initial beach oiling investigation represent only the conditions during the study period.

**Baseline Data Collection**

Baseline data, including beach profiles, surface sediment samples, and short sediment cores, were collected from May 7th through May 19th, 2010. Seventeen beach sites, extending from the western tip of Dauphin Island, Alabama (at the breach induced by Hurricane Katrina) to the eastern end of Santa Rosa Island, Florida (at East Pass) were investigated (Figure 1). In addition, six fringing marsh sites in the eastern portion of Mississippi Sound were examined. The spilled oil had not reached the study areas during the baseline data collection.

Overall, the studied barrier island beaches are characterized by texturally and compositionally mature, very well-sorted white medium quartz sand (Figure 2). Varying
amounts of shell debris are often present in the swash zone. Figure 3 illustrates an example of the baseline data collection at an emerged attachment bar at the mouth of Mobile Bay. Surface sediment samples were collected at various cross-shore locations, and typically include approximately low tide line, mean sea level, high tide line, active berm crest, dune, bayside shoreline, and bayside low tide line. Several short cores, approximately 60 cm in length, were collected typically in the swash zone and near the high tide line. The majority of the cores are composed of homogeneous white medium quartz sand (Figure 2). Shell layers of coarser grain size were found in some of the locations (Figure 2). Influences of the more permeable shell debris to the oil-sand mixing will be examined.

Figure 1. Locations of pre-beach-oiling baseline data collection. Seventeen beach sites and six marsh sites were investigated.

For the several fringing marsh sites in the Mississippi Sound, a short core was collected at the distinctive marsh shoreline (Figure 4). The marsh sediment is characterized by soft, organic rich mud. A very gentle and wide sub-tidal zone occurs around the marsh shoreline.
Figure 2. Image of the coring operation in the swash zone along the white sandy beach typical of Alabama and north Florida coasts. The example core stratigraphy illustrating the homogeneous white quartz sand (left), and a shell-debris layer (right). Photo was taken on May 7th, 2010.

Figure 3. An example of baseline data collection including the surveyed beach profile, locations of the surface sediment samples, and locations of the short cores.
Figure 4. The short core collected from the fringing marsh in the Mississippi Sound illustrating organic rich soft mud.

The pre-beach-oiling data were collected along pristine (e.g., state or national parks) as well as heavily developed (and often nourished) stretches of beach. The overall barrier-island morphology was strongly influenced by recent hurricanes, including Ivan in 2004 and Katrina in 2005 (Wang et al., 2006; Wang and Horwitz, 2007; Claudino, Wang, and Horwitz, 2008, 2010), which resulted in numerous low-lying washover and inundation terraces and low dunes of typically less than 6 m high. The studied marsh islands are pristine and often serve as bird sanctuaries.
Assessment of the Initial Beach Oiling of the Spilled Oil: June 6 through June 9, 2010

The initial beach oiling occurred in the form of so-called “tar balls”. The term “tar ball” is not an accurate descriptor, as most of the beached viscous crude oil is neither tar nor shaped like a ball. However, in the following, the term “tar balls” is used to maintain consistency in terminology with popularized and easily recognized labels, despite the above inaccuracies. In addition to the above 17 study sites (Figure 1), 7 more sites were investigated to improve spatial coverage. Overall, the initial beach oiling at all study sites occurred in the form of discrete tar balls but with laterally varying spatial density. No large “sheet” of crude oil was observed at the study sites. It is worth emphasizing again that the beach oiling is evolving rapidly over time, driven strongly by specific weather conditions. The present assessment represents only the initial beach oiling through June 9th, 2010. Various degrees of cleanup efforts, especially along heavily utilized sections of the beach (both recreational and residential), may influence the assessment and is noted in the following discussion.

Cross-shore and Vertical Distribution of Beached Oil

Majority of the beached tar balls were found in a distinctive zone between the active berm crest and the limit of maximum wave runup (Figure 5). Maximum wave runup is the upward-most limit (vertical excursion) of the total water level produced by combined tide, wave setup, and swash uprush (Roberts, Wang, and Kraus, 2010). The active berm crest typically develops above the mean high tide line. A gently landward dipping beach exists landward of the swash zone along some of the studied beaches, as illustrated in Figure 3 between 0 m and approximately 20 m. The area between the berm crest and the maximum wave runup receives “berm overwash” (Horwitz and Wang, 2007) and is the most vulnerable for tar ball
accumulation. The tar balls that were deposited landward of the active berm crest also have higher preservation potential. No deposited or buried tar balls were found in the active swash zone during this investigation of initial beach oiling.

Figure 5. Cross-shore distribution of beached oil. Note that most of the oil is distributed between the active berm and the maximum wave runup, Dauphin Island, Alabama. It is speculated that the loosely packed sand dike was constructed to prevent oil from reaching farther into the interior of the barrier island. Photo was taken on June 7th, 2010.

Buried tar balls were found at several of the study sites, also largely confined to the zone between the active berm crest and maximum wave runup limit (Figures 6 and 7). The buried oil can be easily exposed during subsequent tidal cycles if the active berm experiences erosion (Figure 6), or may remain buried for a certain period of time (Figure 7). The active berm is very dynamic in nature, with its morphology changing on the order of individual tidal cycles. In
addition, substantial changes can and will likely occur during storm conditions. The buried oil is more difficult to remove and may decay more slowly than the exposed tar balls and therefore, can have longer term effects. As shown in Figures 6 and 7, tar balls were buried up to 8 cm below the surface in 2 to 3 days. It is worth noting that the wave conditions were mostly calm (visual estimates of 0.2 to 0.5 m breaking wave height) during the days of the initial beach oiling. The distribution pattern and burial may be significantly different under different wave conditions. No buried tar balls were found in the active swash zone, consistent with the absence of tar balls there on the surface.

Figure 6. Buried and subsequently exposed oil within the active berm. Scale along the right side of the ruler equals 2.54 cm. Photo was taken on June 7th, 2010.
Figure 7. Buried oil just landward of the active berm. Scale along the right side of the ruler equals 1.0 cm. Photo was taken on June 8th, 2010.

**Alongshore Distribution of Beached Oil**

A regional-scale assessment of the alongshore distribution of beach oiling was conducted. Five qualitative contamination grades were classified based on an ordinal scaling scheme and estimated visually. Grade 5 has abundant tar balls, with 80 to 100% of the areas having tar balls (Figure 8). The “area” here is defined as the region approximately from the active berm crest landward to the maximum wave runup based on the observed horizontal distribution, as discussed above. Grade 4 represents somewhat abundant tar ball occurrence in 60-80% of the area. Grade 3 represents somewhat concentrated tar balls, with 40 – 60% of the sampled areas contaminated (Figure 9). Grade 2 has sporadic occurrence of tar balls in 20-40% of the area.
Grade 1 represents sparse tar ball occurrence in 0 to 20% of the area. The tar balls in Grade 5 contamination (Figure 8) tend to be larger than those within the lower grade contaminations (e.g., Figure 9).

Figure 8. An example of the densest beached oil observed during the initial assessment. Grade 5 beached oil. Photo was taken on June 7th, 2010.

The local occurrence of tar balls is influenced by beach morphology. Beaches with a steep foreshore and no active berm tend to have less tar balls, while beaches with a gentle foreshore
and distinctive active berm tend to have more tar balls. Considerable uncertainties may be associated with the visual estimates of the spatial densities of the tar ball distribution. A main factor influencing the tar ball estimates is the cleanup efforts. The beach cleanup tends to be concentrated along the heavily used beaches. However, the tar balls apparently were difficult to be completely removed, typically leaving small pieces and sometimes buried oil, often resulting in a classification for the cleaned beach of Grade 2 contamination.

Figure 9. An example of scattered small tar balls. Grade 3 beached oil. Photo was taken on June 8th, 2010.
Figure 10. Distribution of beach oiling along the Alabama and north Florida beaches. Beached oil was found along approximately 160 km out of the 180 km studied sandy beaches. Spatial intensity of the beached oil decrease generally from west to east.
The regional distribution of beach oiling is illustrated in Figure 10. Overall, an eastward decreasing trend was observed. The most intense oil contamination occurred along the western portion of Dauphin Island. In addition, the bayside beach there was also contaminated by the oil moving through the Katrina breach. Beaches along both sides of the Mobile Bay entrance are relatively less contaminated. The Gulfside beach along the emergent attachment bar (also called Pelican Island) to the west of the Mobile Bay entrance was intensively cleaned. The lower estimate of a Grade 2 (Figure 10) may be influenced by beach cleanup efforts. The bayside beach along the Pelican Island and Dauphin Island shorelines landward are free of oil. Low grades (2 and 1) of oil contamination were also observed along the east side of Mobile Pass. As a matter of fact, beaches in the vicinities of the two other major inlets, Perdido Pass and Pensacola Pass, are relatively less contaminated, as compared to beaches further away from the inlets. A considerable amount of oil reportedly entered Perdido Pass on June 9th, 2010 (Personal Communications with David Tidwell, Alabama Geological Survey). However, the adjacent beaches did not receive significant oil. It is likely that the tidal inlets tend to confine the oil in their flow fields and retard oiling of immediate adjacent beaches. The high grades of oil contamination (3 and 5) in the eastern portion of Perdido Key (Figure 10 middle) were associated with beach oiling at the time of the field investigation. The eastern half of Santa Rosa Island has not received any significant amount beach oiling.

Several small interior lagoons exist along the studied stretch of coastline. Some of these lagoons are connected to the Gulf of Mexico through small inlets. In order to prevent oil from reaching the lagoons, the inlets were artificially closed. The closed portion of one of the inlets at Gulf Shores, Alabama was heavily contaminated (Figure 11).
Summary

This progress report summarizes the initial findings of the baseline data collection and the field investigation of initial beach oiling. Overall, beaches along the Alabama and north Florida barrier islands are characterized by mature well-sorted medium white quartz sand. Varying amounts of coarse shell debris are distributed in the swash zone.

The initial beach oiling of the Deepwater Horizon spill along the studied coastline occurred on June 3rd, 2010. Oil tar balls were found along approximately 160 km of the overall 180 km of
the studied shoreline. The intensity of beach oiling decreases generally from west to east. The initial beach oiling by tar balls can be mostly controlled by manual cleanups. However, the cleanup efforts could not remove all the tar balls, typically leaving a Grade 2 level contamination of small tar balls. Tidal inlets appear to have confined the oil to within their flow field resulting in a reduced level of contamination along the adjacent beaches, as compared to beaches further away from the inlets. The findings here represent conditions along the studied stretch of coastline through June 9, 2010, and include results associated with varying degrees of beach cleanup.

References


