BP Deepwater Oil Spill - The Oil in the Water, Seeps, and an Open Thread

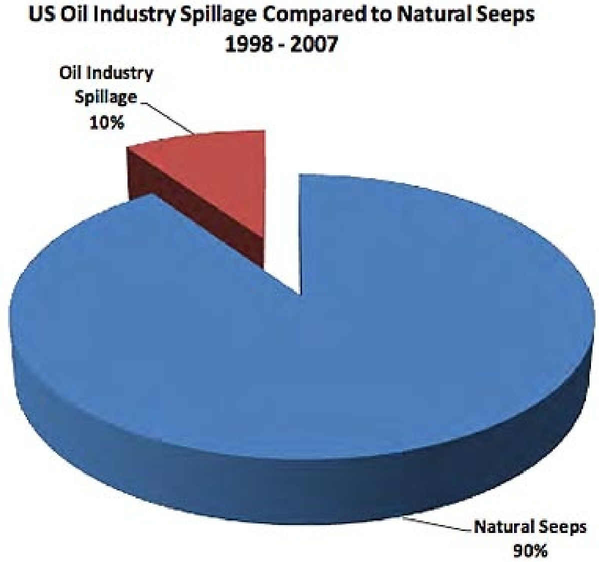
Posted by Heading Out on June 8, 2010 - 8:30am
Topic: Environment/Sustainability
Tags: deepwater horizon, oil seeps, oil spill [list all tags]

Senator Bill Nelson of Florida spoke on MSNBC on Monday, about the possibility of oil leaking up from the seabed in the vicinity of the Deepwater Horizon well that is currently spilling oil into the Gulf. (The implication being that the well casing had "sprung a leak.") The story will inevitably grow, but it may well be that he is confusing two quite separate events. You might remember that when tar balls first started appearing on the Florida beaches recently they were analyzed, and on May 19th the Coast Guard issued a statement that included the following:

> A sampling of tar balls discovered on beaches at Fort Zachary Taylor State Park, Fla., Smathers Beach in Key West, Big Pine Key, Fla., and Loggerhead Key in the Dry Tortugas National Park, Fla. were flown by a Coast Guard HU-25 Falcon jet based in Miami, Fla., to New London, Conn. Tuesday for testing and analysis.
>
> The results of those tests conclusively show that the tar balls collected from Florida Keys beaches do not match the type of oil from the Deepwater Horizon oil spill in the Gulf of Mexico. The source of the tar balls remains unknown at this time.

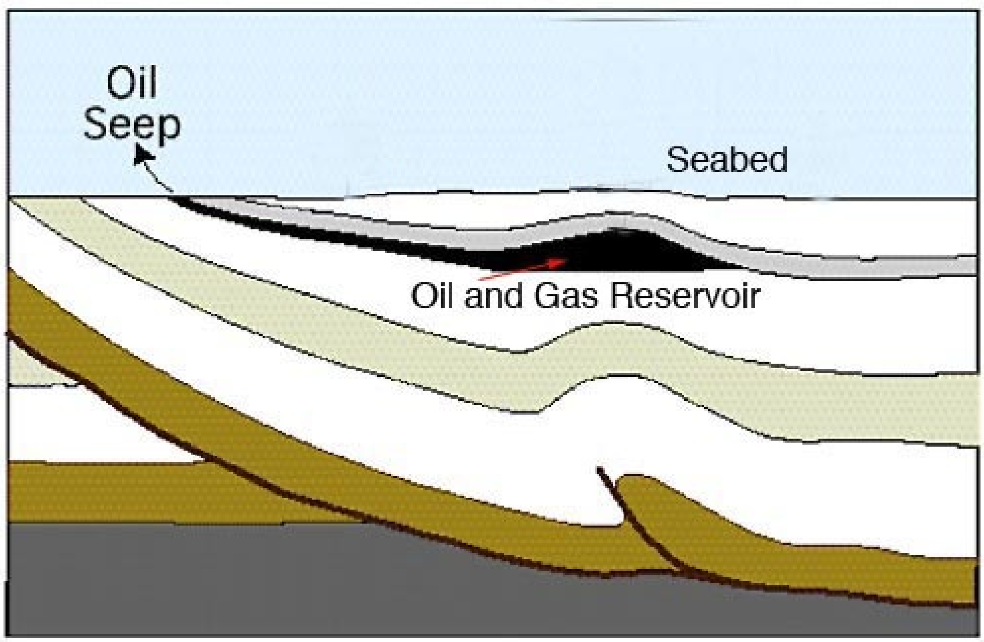
At that time it was conjectured that the tar balls had come from natural seeps under the Gulf. Cutler Cleveland recently wrote a guest post on the topic of these natural seeps, and their size, relative to the current spill, but because of the new furor I thought it worth expanding a little on what he wrote, relying on two of his sources – the National Research Council's Oil in the Sea III Inputs, Fates and Effects (2003) ; and Dagmar Schmidt Etkin's Report "Analysis of U.S. Oil Spillage," which API issued last August.

In the normal course of events the magnitude of the natural seeps of oil into the waters around the United States far exceeds that from other sources. For example, to take the data for U.S. waters:



Comparison of seeps and typical annual spill volumes (after Etkin-ibid)

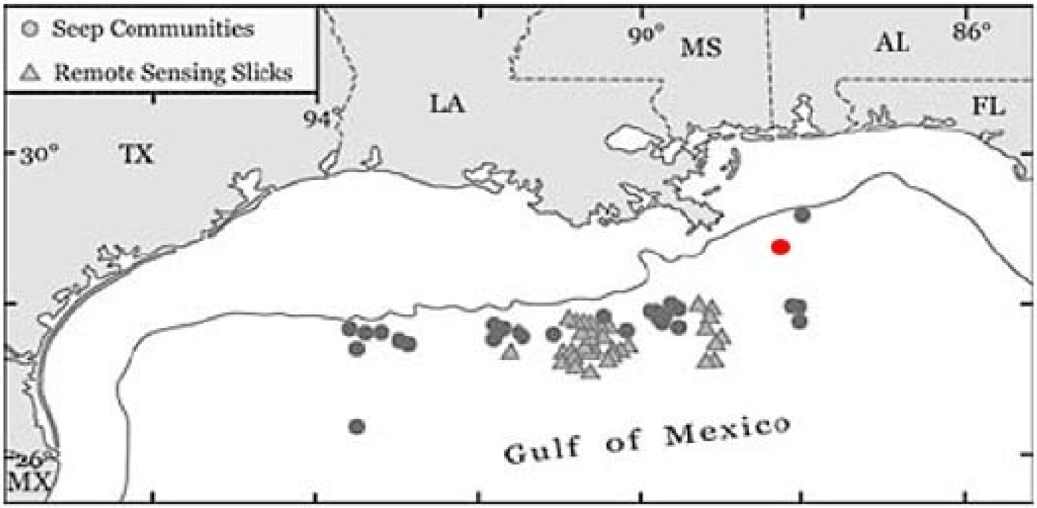
A natural seep occurs when the oil, which is normally trapped under a layer of rock in a reservoir, finds a pathway to the surface, generally relatively small (so that the oil doesn't all gush out rapidly), with the oil slowly seeping upwards over the centuries.



Oil seep from reservoir under the sea (after USGS/Etkin ibid)

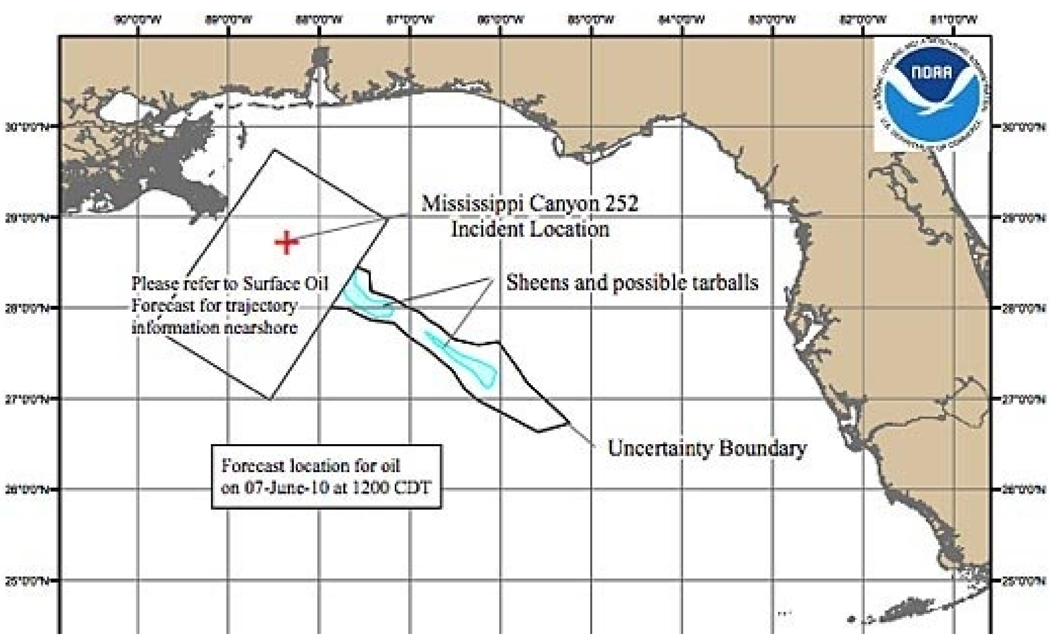
Worldwide seeps can add up to more that 14 million barrels a year, and in the Gulf of Mexico the NRC report suggests that the annual flow from the seabed is around 1 million barrels/year. (Etkin puts the high end estimate at 1,400,000 barrels a year). As Dr. Cleveland notes this is considerably less than the current spill (2,700 bd against 15,000 bd), but it is sufficient that it generates tar balls that end up on Florida beaches, and it is likely sufficient to also generate plumes of oil-contaminated water. Further the location of these seeps, not surprisingly, is where the oil rigs are likely to be found (since they are drawing oil from the reservoirs). Thus it may well be, in this case, that there is some confusion between natural seeps and the entirely un-natural and much larger current spill.

Etkin mapped the location of the seeps that have been reported, and areas where the sheen of oil that they generate on the surface has been remotely detected.

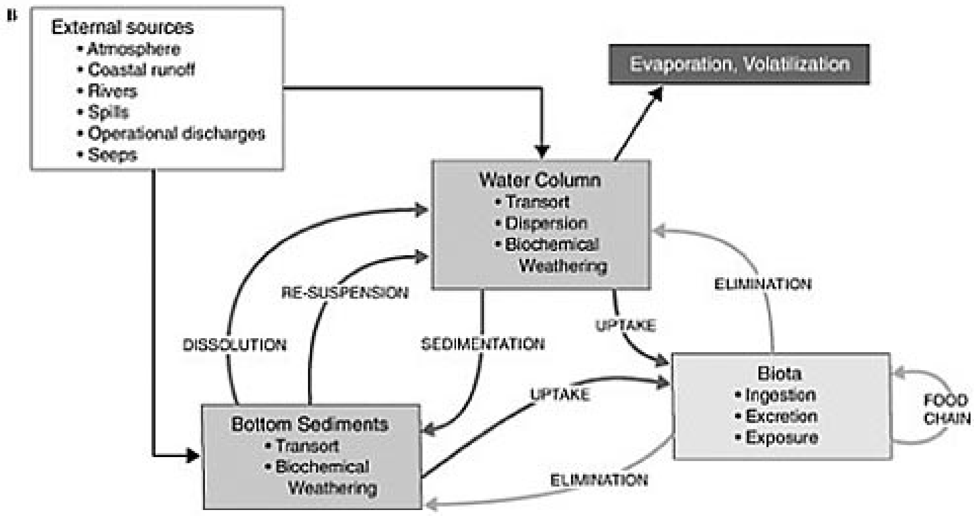


Reported natural seep locations in the GOM.

It is perhaps useful to locate the Deepwater Horizon oil spill relative to these. (I have put a red dot on the above map where I estimate it is, but this is the NOAA map showing [the well location and the surface sheen]today (June 7th).



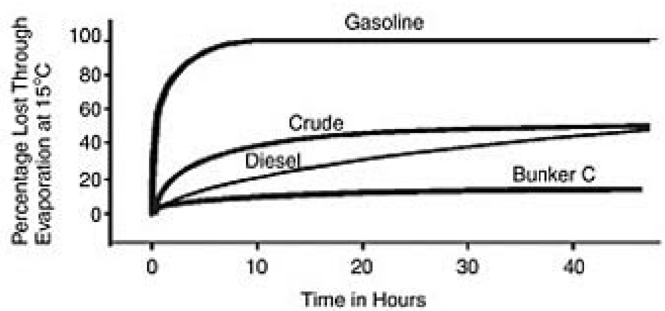
The surface sheen will, unless continually fed with new oil, tend to shrink over time as the oil that comprises it is light enough to evaporate. The NRC Report notes that there are a variety of ways in which the oil will meet its fate.



Fate of the oil entering the Gulf (NRC report – ibid)

The NCR report provides this graph for the evaporation rates (but remember that this is likely only valid for the very thin layer of oil on the surface).

> In many oil spills, evaporation is the most important process in terms of mass balance. Within a few days following a spill, light crude oils can lose up to 75 percent of their initial volume and medium crudes up to 40 percent. In contrast, heavy or residual oils will lose no more than 10 percent of their volume in the first few days following a spill. Most oil spill behavior models include evaporation as a process and as a factor in the output of the model.



Evaporation rates for various hydrocarbons (NRC report – ibid)

On the other hand emulsification (where the oil mixes with water to generate the brown chocolate mousse type of structure that is now appearing along the beaches, marshes and estuaries) increases the volume of the oil by perhaps 3 – 5 times. This is the most visible result of the spill, with the long strands of emulsion that are now evident on the sea surface and which are now entrapping birds and other wild life. It is not, however, likely to be the most dangerous.

That comes from the concentration of small oil droplets in the water. While these are small enough to be an easy target for microbial action, and in that process of being digested, reduce the risk of tar ball and sediment formation which is often the long term result of an oil spill, before this plume is destroyed it can be lethal to those bethnic resources that it encounters. Following the wreck of the tank barge the *North Cape* off the Trustom Pond National Wildlife Refuge in New Jersey the impact was devastating.

> Nearshore benthic resources were greatly impacted, with estimated mortality of 9 million lobsters (mostly juveniles), 19.4 million surf clams, 7.6 million rock and hermit crabs, 4.2 million fish, and 2.8 million kilograms of amphipods and worms

In that case, however, the wreck was pushed ashore at the refuge. In the current case there are miles, for some species, between the spill and their habitat.

With the breakdown in size of the oil droplets brought about by the dispersant mixed in with the oil at the well, the exposure of the oil to microbial action is enhanced, because of the very large surface areas which the droplets create. This will speed up biodegredation, but it depends on depth and water temperature, among other factors.

> Rates of biodegradation are dependent on the ability of microbes to contact hydrocarbons as well as on the bacterial metabolic processes operating within the cell. Rates of biodegradation in a natural experiment range from 50 to 100 g/ m3 per day (Lee and Levy, 1987). In the environment, rates of degradation have been reported to be between 0.001 and 60 g/m3 per day (Atlas and Bartha, 1992) *Source: (NRC Report – ibid)*

Also, in regard to a certain BP official commenting that oil floats, this depends on the droplet size, to quote the report again:

> Vertical dispersion and entrainment are the movements of oil droplets of sizes less than about 100 µm into the water column. Typically droplets that display a residence time of minutes to hours have droplet sizes less than about 20 µm (Reed, 1992). Larger droplets will rise quickly to the surface.

Unfortunately the exact droplet sizes, and their relative lifespan at different levels in the water column is going to be partially controlled by the earlier interaction with the dispersant.

That research will, no doubt, now be done relatively rapidly, given the $500 million that has been made available and the groups now doing the investigating. It will, as part of that process, perhaps be interesting to see how much of some of these subsea plumes was generated by the natural seeps, rather than the oil spill, and how the natural disposal of that oil impacts on the current much larger volumes. But again that funding is likely already starting to be spent. (Were I still doing active research I would probably grumble more about the lack of funding for research to find better ways of drilling and producing the oil – but since I'm not, I will restrain my cynical self).

And on a final note: The amount of oil being recovered at the Deepwater site has now risen to a daily rate of 15,000 bd. (But does not seem to have impacted the volumes escaping from under the cap.)