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Ocean Science
Discussions

Interactive comment on "Seawater capacitance – a promising proxy for mapping and characterizing drifting hydrocarbon plumes in the deep ocean" *by* J. C. Wynn and J. A. Fleming

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RESPONSE TO D. SNYDER COMMENTS, 12 September 2012

It is a pleasure to respond to this astute review.

Dr. Snyder's thinking about the mechanism for this remarkably strong observed Induced Polarization ("IP") response to oil dispersed in seawater mirrors our own. Early on, we realized that high-frequency measurements would severely attenuate our sampling distance in the deep ocean. We therefore chose to experiment only with the lower "traditional" IP frequency range (0.1 – 72 Hz). This frequency range would give us a reasonable chance of sampling a large volume of seawater rapidly enough to make

this approach both realistic and achievable. We believe the physical mechanism is not dielectric in character (we see the strongest effect at very low frequencies), but instead is ion adsorption and relaxation in a double-layer effect onto the oil surface - in other words, something closely akin to Warburg impedance.

The next step of scaling up the measurements to a volume "on the scale of cubic meters" is one of our hopes, but awaits the time and resources to build an appropriate laboratory infrastructure.

Dr. Snyder's observation that the noise envelope should be more like 0.1-0.2 milliradians (mr) is exactly in line with our own assessment. However, during internal US Geological Survey technical review prior to submitting this paper, we were asked to take the most conservative value of 1.0 mr. A realistic detection envelope of 2 – 3 times the noise threshold (whatever that may be) is something we also strongly agree with. These two would tend to balance out, and a 0.1% detection limit for oil in seawater is probably a safe, conservative estimate for typical ocean survey conditions.

As Dr. Snyder observes, EM coupling effects will be constant (and therefor easily removed) except when shallow water with substantial bottom topography is involved. Survey procedures, however, could be adopted in shallow water to minimize these irregular signal contributions. Frequency- vs time-domain measurements are also moot, as in modern IP systems the frequency-domain signal is Fourier transformed to provide phase-shift and amplitude as a function of frequency.

Dr. Snyder suggests, and we heartily concur, that "Broadband measurements in the frequency domain are appropriate for the purpose of characterizing the nature of the plume and should be conducted at minimal speed in order to permit the transmission of low frequency waveforms and to allow stacking and averaging." We are interested as much in where the plume is moving as in characterizing how it biodegrades and disperses, and broadband measurements are key to the latter.

Interactive comment on Ocean Sci. Discuss., 9, 2679, 2012.