Induced Polarization Associates LLC

Marine Induced Polarization

An Electrical In-Water Hydrocarbon Detection Technology

Presentation March 29, 2018

Alaska
Oil Spill Technology Symposium
March 28 – 30, 2018
The Hilton Hotel
Anchorage, Alaska

Kevin Hand Induced Polarization Associates







March 29, 2017 - "If you can't see spilled oil, how do you find it and clean it up?"

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Marine Debris

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About

High Water and Sunken Oil on the Great Mississippi

March 29, 2017 - If you can't see spilled oil, how do you find it and clean it up?

That's the situation emergency responders faced in two oil spills on the Mississippi River that challenged their understanding of how to approach evaluating oil spill conditions.

The first incident was Sept. 3, 2015 when two tow barges collided on the Lower Mississippi River near Columbus, Kentucky. The second was Jan. 21, 2016 when a barge towed by the UTV Amy Frances struck the Natchez Bridge on the Lower Mississippi River. The Lower Mississippi is the most traveled and commercially important portion of the river's system.



USCG conducting initial damage survey of barge from the UTV Amy Frances. Credit: U.S. Coast Guard

On Our Radar

Response Tools for Spills



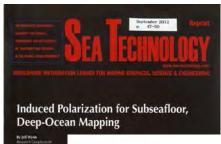
Meet the New CAMEO **Chemicals Mobile App**



Preparing for Hurricane Season



Marine Induced Polarization



www.ocests-sci.net/8/1099/2012/ doi:10.5194/au8-1099-2012 C Author(s) 2012. CC Attribution 3.0 Liceuse.



Seawater capacitance - a promising proxy for mapping and characterizing drifting hydrocarbon plumes in the deep ocean

Cascades Volcano Observatory, US Geological Survey, 1300 SE Cardinal Ct, Vancouver, WA 98683, USA ²Zonge International, 3322 E. Fort Lowell Road, Tucson, AZ 85716, USA

Correspondence to: J. C. Wynn (jwynnia usgs gov

Received: 25 April 2012 - Published in Ocean Sci. Discuss. 3 August 2012 Revised: 28 November 2012 - Accepted: 30 November 2012 - Published: 18 December 2012

Abstract. Hydrocarbons released into the does ocean are the world's oceans (Yana and Chen, 2004). Where the coman inevitable consequence of natural steep, seafloor drilling, plex hydrocarbons end up after such an event is important to and leaking wellhead-to-collection-point pipelines. The Macoads 252 (Decreater Horizon) well blowout of 2010 was cay, evaporation, skimming and burning, and "naturally dis-1979. History suggests it will not be the last accidental release, as deepwater drilling expands to meet an ever-growing sear, 2010). Dissofted oxygen concentrations suggest that denual. For these who must respond to this kind of disaster, the first line of action should be to know what is going on. sea, on the order of I micromolar axygen per day (Canulli This includes knowing where in oil plame is at any given et al., 2010). As a revall, a deep plame is thought to have ing or degrading. We have experimented in the laboratory died kilometers from the Macondo well during 2010 (Kessler with induced polarization as a method to track hydrocarbons in the separater column and find that finely dispersed oil in electrical army could be used to man and characterize such seawater gives rise to a large distributed capacitance. From evolving plannes in the future. rvious sea trials, we infer this could potentially be used to than 0.001 oil-to-seawater, drifting and evolving in the deep evolves and degrades in space and time. One way to do this ocean. A side benefit demonstrated in some earlier sea trials is that this same approach in modified form can also man certrin heavy placer minerals, as well as communication cables, ninelines, and weeks buried beneath the scaffore.

scientists, policy planters, and brigants. After direct recoveven larger than the Ixxoc event in the Gulf of Campeche in persed components are counted, the whereabouts of at least time, where and how fast it is moving, and how it is evolve advected away in the Gulf Loop Current at least several hun-

both man and characterize oil plannes, down to a ratio of less - Indrocarbon release must be married in 3-D, to see how it is by cable-lowered rosette sampling (Breier, et al., 2010) expensive, requires downstrain mass spectrometry or subsecuret chemical analysis, and provides only a narrow vertical profile sample while a plame is moving past it. Another

Excerpt: Ocean Science

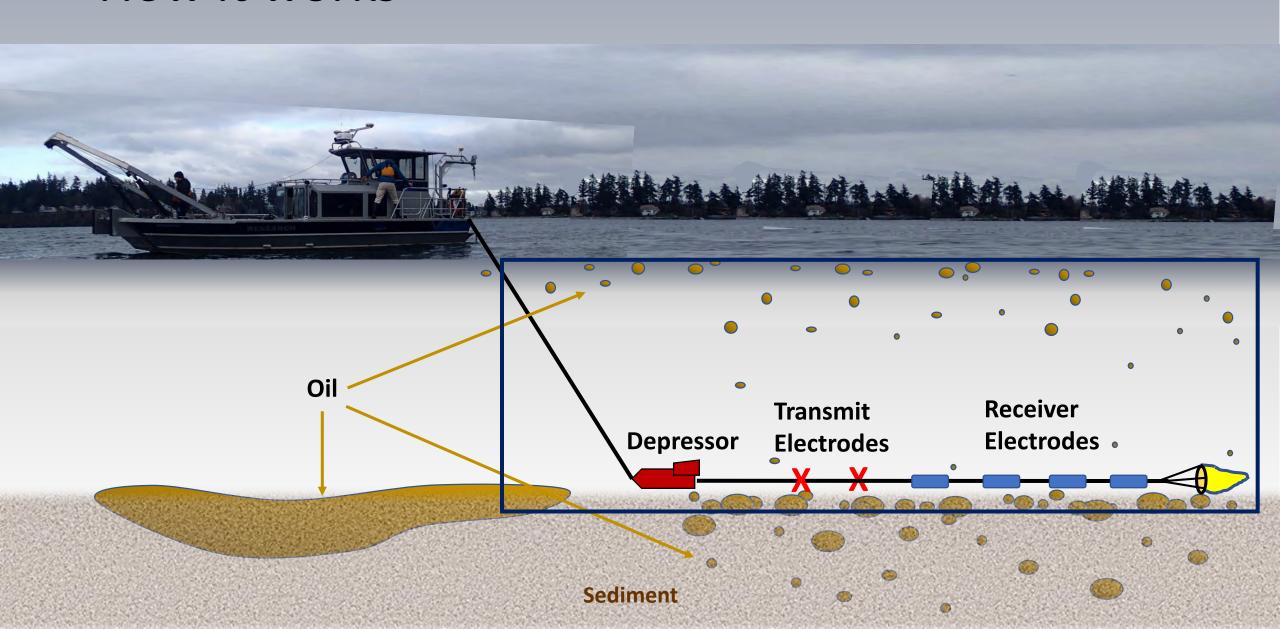
PEER-REVIEWED SCIENCE

An Introduction:

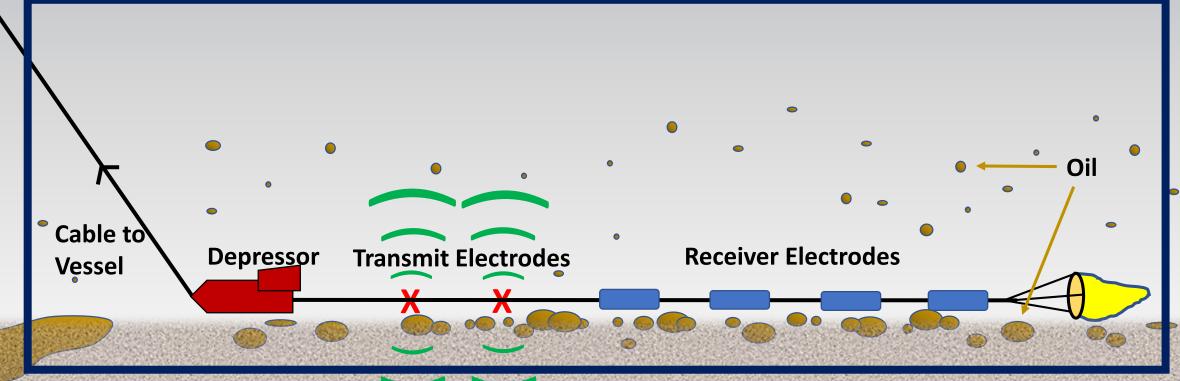
- 2016: Induced Polarization Associates LLC was formed to explore the *commercial* applications of Marine Induced Polarization
- Proven technology relating to hydrocarbon detection
- Investigating the practicality of applications which benefit the oil spill community

A Brief History...

- Induced Polarization (IP) has been used on land for more than a half-century, its initial application aimed at mining for precious metals.
- Recently the focus has been on detection of hydrocarbons and associated derivatives in the water column, on sea and river beds, or sequestered in bottom sediments.
- Measurement of non-floating oil substances, both from industrial sources and collected weather-altered field samples, have been tested with similar positive results

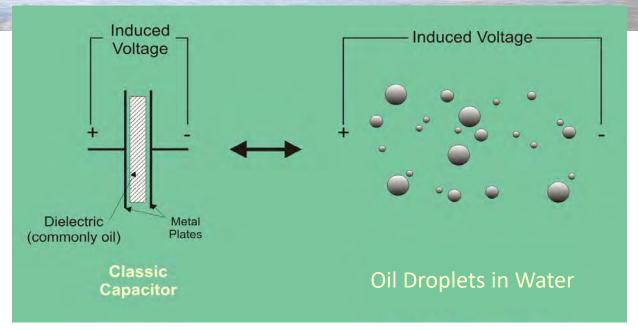


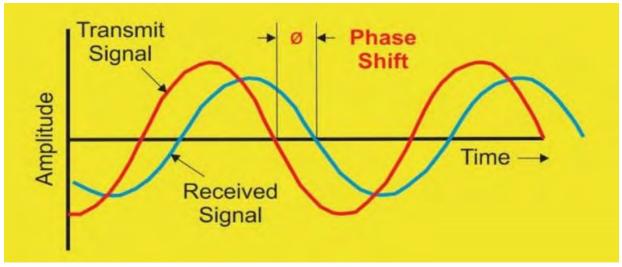
- A controlled electrical current is introduced into sea/river water
- The resulting voltage developed between paired receiver electrodes is acquired



Acts as a capacitor

• The phase shifts between the current and the voltage are used to identify anomalies, such as hydrocarbons.





Specifications

- Salinity: Sea Water, Rivers, Lakes
- Minimum Temperature (°C): -2
- In laboratory, detection of oil down to 2 ppm
- Current cable configuration:
 - ➤ Total length: 160m
 - > Weight: ~150 lbs.
- Cable's breaking strength: 6500 lbs.
- Water depth: 1m to Full Ocean Depth
- Penetration in sediment: Down to 20m
 - > Transmitter/receiver geometries are adjustable
 - ➤ The distance between receiver electrode pairs determines depth of penetration.

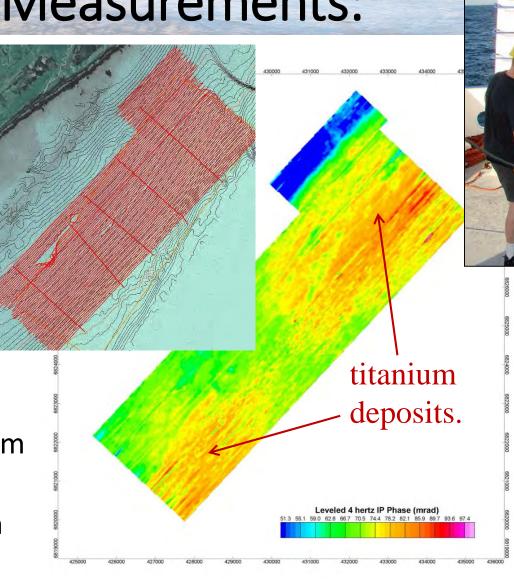




Seawater Field Measurements:

South Africa

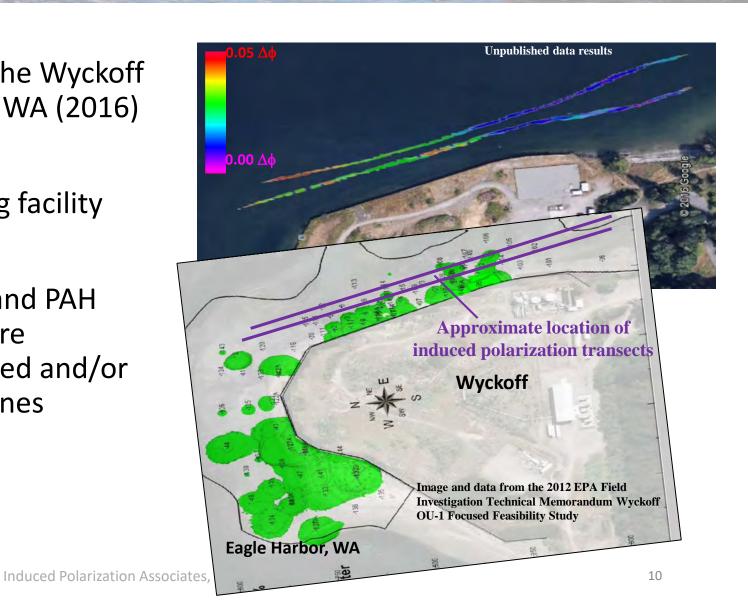
- Commercial marine IP survey in South Africa
- Discovered 2 large & hidden placer titanium deposits
- Invisible to ROV or diver
- Survey area: 3.5km x 11km
- 25-day survey with 100m line spacing





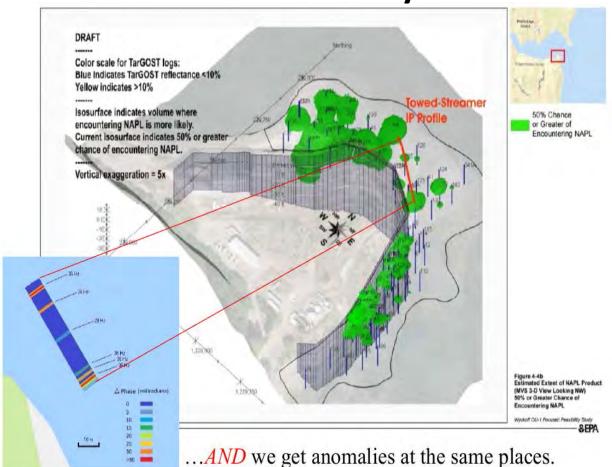
Seawater Field Measurements: Wycoff

- Field trials were conducted at the Wyckoff superfund site in Puget Sound, WA (2016)
- Former creosote manufacturing facility
- Pockets of creosote/tar, NAPL and PAH have either been capped and are randomly extruded to the seabed and/or transported to the intertidal zones

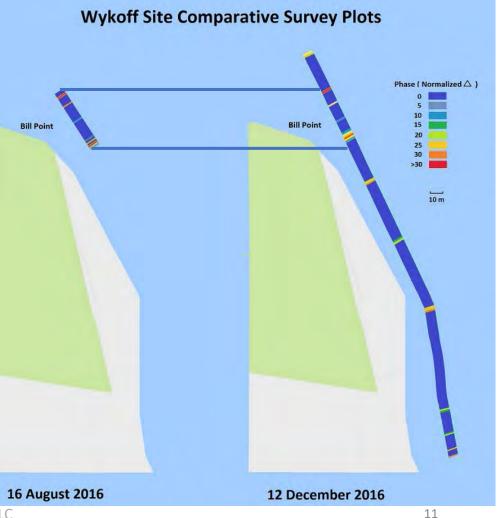


Seawater Field Measurements: Wycoff

Comparison Check: EPA TarGOST Survey Results



Replication Check:



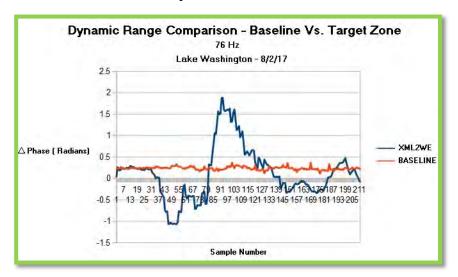
Freshwater Field Measurements:

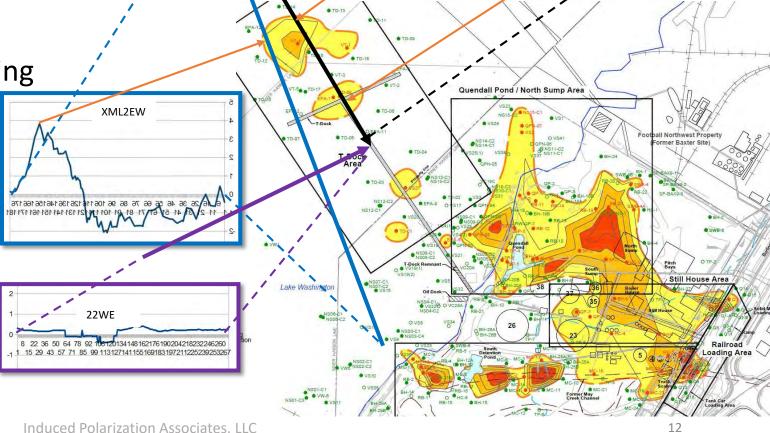
Lake Washington

 Field trials were conducted at the Quendall Terminals superfund site in Lake Washington, WA (2017)

Former creosote manufacturing

facility



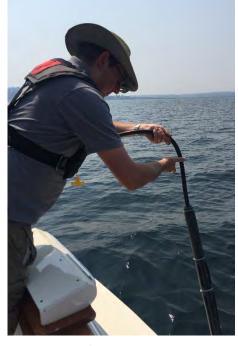


XML2WE

Field Operations

Deployment & Recovery







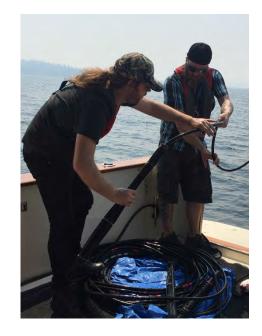




Cable being towed

Vessel requirements

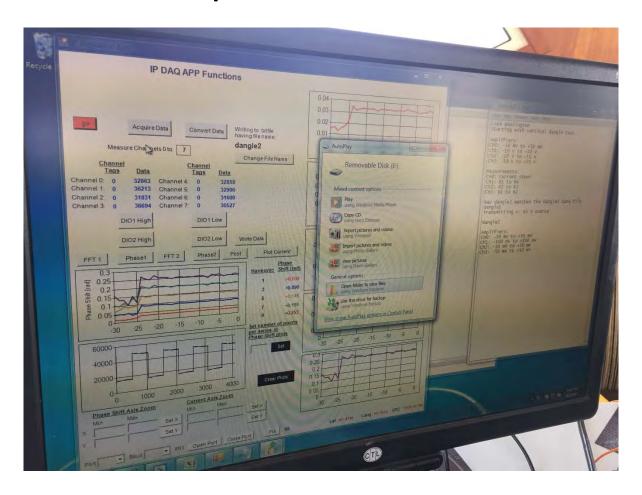
- Minimum 25 ft.
- Protected area for electronics
- 4 x 8 ft. deck space
- Ability to travel =< 3 kts



Hand Recovery

Field Operations

Data acquisition





Field Operations

Data products

- Data files
 - *.txt
 - *.CSV
 - *.xls
 - 3D Voxels
 - & Others
- Graphics files
 - Georeferenced maps
 - *.KMZ
 - Shapefiles
 - & Others

Example 10-min Product



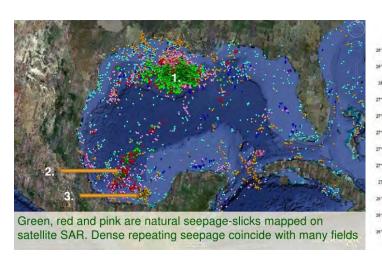
Example for Reporting

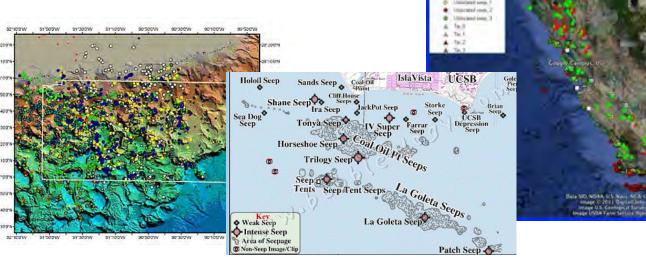


- Baseline Characterization
- Offshore Spill Response
- Nearshore, River, Fresh Water Incidents
- Legacy Spills
- Potential for Plastics

Baseline Assessments – Categorizing Environmental Liability

- ➤ Mapping of existing oil seeps
 - Extent & Location of existing source releases
- ➤ Pre-existing contaminations
 - Prior E&P activity
 - Adjacent operators: source contamination potential





KMZ of California

Oil & Gas Seeps from 1987 CA DOC Pub.

Spill Response

- ➤ Mapping of Oil in/on Sediment
- ➤ Potential: 3D Mapping of water column
 - Real-time data returns of extent
- > Potential: Monitoring the movement of spill
 - Confirm validity of Trajectory Modeling
- > Potential: Shoreline Incursion "ALARM"
 - Near-shore / Sensitive Area Warning System



Nearshore, River, Freshwater Incident Response

- > IP is capable of strong signal returns in fresh & brackish water environments
 - Pipeline river crossings leak detection
 - Static monitoring at inflows / outflows
 - Spill response/monitoring in shallow river deltas

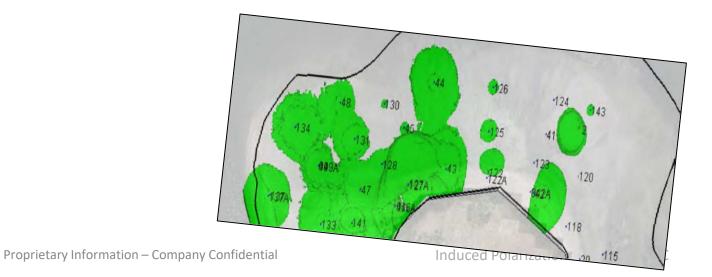


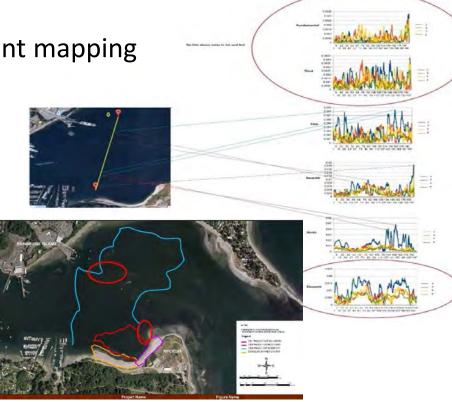
Marine IP Applications

Impact Assessments and Legacy Spills

➤ Identification of Location & Extent of Contaminated and Uncontaminated Areas

- Single towed cable + detection into sediment = efficient mapping
- Fills in otherwise interpolated areas between cores
- Enables targeted & reduced sediment sampling





Example: Survey of Wycoff legacy contaminated site

Marine IP Applications

Plastics

- ➤ IPA has made *preliminary* lab measurements suggesting some plastics react to Induced Polarization techniques
- Potential Applications:
 - Microplastics detection & mapping
 - Marine debris at sea
 - Nearshore contaminations
 - Reef & other underwater critical habitats
 - Sensitive Areas: Estuaries, Refuges
- > Further possibilities:
 - Lab testing is required for expanded sample sets

	Dielectric Strength		Dielectric Constant			Dissipation Factor		
bbreviation (chemical name)	Volts	0.001"	e	@	e	@	@	e
rand name	0.001"	0.005*	1KHz	1MHz	1GHz	1KHz	1MHz	1GHz
CTFE (ethylene chlorotrifluoro	5000							
thylene copolymer)	6000		2.6	2.6		0.002	0.013	
TFE (ethylene tetrafluoro-	5000	2500	2.6	2.6	2.4	0.0008	0.005	0.0005
thylene copolymer) Tefzel	3000	2900	2.0	2.0	2.4	0.0008	0.005	0.0003
EP (fluorinated ethylene-	6500	2000	2	2	2.05	<0.0002	0.0003	0.0015
ropylene copolymer) Teflon FEP	6500	2000	2.5	2.05	2.05	<0.0002	0.0003	0.0015
FA (perfluoroalkoxy)	4000		2	2	2	0.0002	0.0002	0.00045
eflon PFA	5000		2.1	2.1	2.1	o.wod2	unudi	0.00043
CTFE (polychlorotrifluoro-	3000	2700	2.5	2.3	2.3	0.022	0.009	0.004
thylene)	3900	3300	2.7	2.4		0.024	0.017	0.004
TFE (polytetrafluoroethylene)	2200	1000	2	2	2	<0.0001	«0.0001	s0.0001
eflon	4400	2000	2.1	2.1	2.1	<0.0001	<0.0001	<0.0001
VF (polyvinylfluoride) Tedlar	3500	1700	8.5	7.4	****	1.6	******	
VDF (polyvinylidenefluoride)								
ynar	*******	*******	8.4	*****		0.019	******	
oolycaprolactam) Nylon6	(0.002°) 1300	*****	3.7	3		0.016	0.036	
C (polycarbonate) Lexan	6300	2000	2.99	2.93	2.89	0.0015	0.01	0.012
ET (polyethyleneterephthalate)	7500	3400	3.2	3	2.8	0.005	0.016	0.003
tylar	7500	3400	3.2	3	2.8	0.005		0.008
DPE (low density polyethylene)	5000	3000	2.2	2.2	2.2	0.0003	0.0003	0.0003
LDPE (linear low density	5000	3000	2.2	2.2	2.2	0.0003	0.0003	0.0003
olyethylene)	5000	3000	2.2	2.1	2.2	0.0003	0.0003	0.0003
DPE (high density polyethylene)	5000	3000	2.3	2.3	2.3	0.0005	0.0005	0.0005
HMWPE (ultra high molecular	(0.010")		2.3	2.3	2.3	0.00023		
reight polyethylene)	1300		2.3	23	2.3	0.00023	*******	
l (polyimide)	7000	3600	3.5	3.4	3.3	0.0025	0.01	0.004
MMA (polymethylmethacrylate)			3.5	3				
lexiglas	***********	*****	4	3.5	2.58	0.04	0.03	0.009
P (polypropylene)	8000	2700	2.2	2.2	2.2	0.0003	0.0003	0.0003
			2.4	2.4	2.4			
S (polystyrene) Styron	5000		2.7	2.7	2.7	0.0005	0.0005	0.0005
VC (polyvinylchloride)				2.7	2.8	0.009	0.006	0.019
VDC (polyvinylidenechloride)			3.9	3		0.052	0.05	
aran			4.5	4	2.7	0.063	0.08	0.016

Table A: Dielectric properties of various plastics

Comparative Analysis – Level of Effort

Marine IP v. Coring in potentially contaminated soils

Example Survey: Contaminant Delineation of Quendall Terminals Superfund Site

> Survey Efficiency: Able to identify extent of contaminated AND non-contaminated areas

= Efficient, cost-effective, & fast understanding of delineation & extent

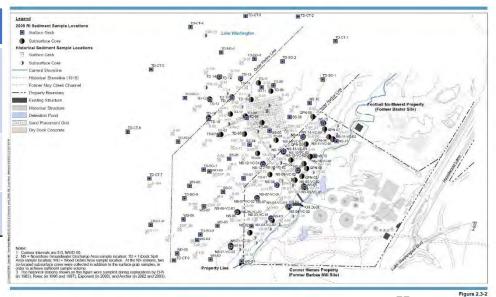
> Rate of Collection: Provides verifiable results with reduced vessel costs, significant reduction of expensive chem analyses, chain-of-custody challenges, etc.

Survey Methodology:	Marine IP	Coring			
Survey Days: Marine IP Survey Sediment Sampling Days Total Vessel Survey Days	1 2 3	0 18 (estimated for 12 coring, 6 grabs) 18			
<u>Data Collection:</u> # of Samples	(estimated: 8 cores, 15 VanVeen Grabs)	350 (actual: 67 Cores, 109 VanVeen Grabs)			
Sediment Chemistry:	\$7,920	\$84,000			

Note: Costs are **ESTIMATES** only for exhibiting efficiencies of Marine IP system

Survey Area: $.1km^2$ ($.3km \times .4km$)

<u>Assumptions:</u> Cores/day = 6; Grabs/day = 20; Samples/Core = 4; Lab Chemistry: \$240/sample



Potential Future Developments

Fueling & Port Monitoring

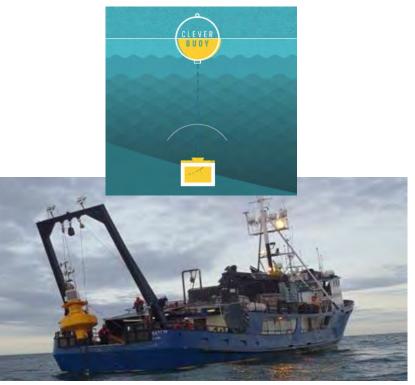
- Shipping fueling ops
- 'Smart Boom': instant alert to leaks
- Improper ballast discharges





Static Mounts (e.g.: Buoys)

- Detection In specific targeted areas
- High-fidelity modeling when used in unison

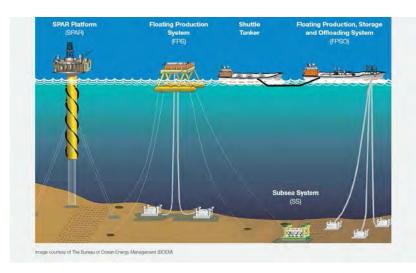


Rig Mounts

- Immediate Leak Detection
- Potential for other identifications:

(e.g.: For regulatory compliance)

- Sewer/effluent discharge
- Operating fluids
- Other contaminants (polarizable)



Proprietary Information – Company Confidential

Induced Polarization Associates, LLC

Advantages

- Compliant with USCG/OSRO guideline with respect to non-floating oil
- Unique in its ability to detect hydrocarbons in the water column, river/seabed and embedded in sediments
- Highly robust and ruggedized
- Easily transportable: small instrument foot print can be mobilized on a vessel of opportunity as small as 25-ft
- Small environmental footprint: In bottom reference mode bottom disturbance no greater than medium sized flat fish.
- On-the-fly interpretable real time displays
 - Fast output a layered geo-plot for onsite
 - Potentially detect and locate leaky outfalls and pipelines

Limitations

- Not optimal for sea surface detections
- Current signature library is still limited, though expanding
- Effect of biofouling on static arrays unknown (primarily a receiver dipole design issue)

Conclusions

- Marine IP is an efficient tool for detection & mapping of non-floating hydrocarbons
- Field-verified technology
- During an incident or for legacy spills, marine IP:
 provides a more complete georeferenced data set
 enables more targeted sediment sampling, reducing costs
- Potential to detect & map oil in water column during incidents
- Potential for oil spill monitoring and early-warning alerts:
 - Ports and Docks
 - Pipeline leaks
 - Intakes, sensitive areas

Thank you!

For more information: Induced Polarization Associates, LLC www.marine-ip.com

Kevin Hand

907.529.6672

Kevin.Hand@intellisensemarine.com