Redox transformation of mercury in coastal seawater: Gwangyang Bay, Korea

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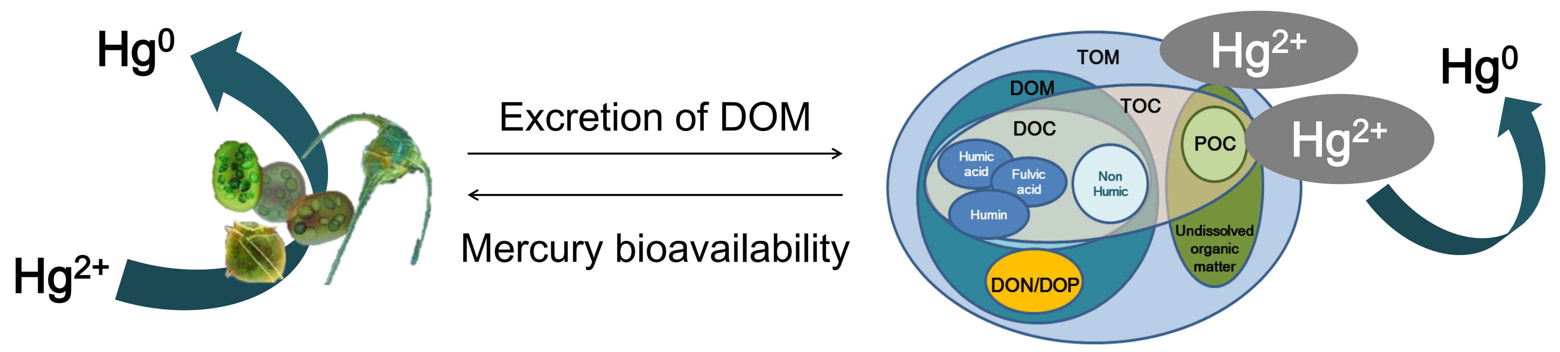
Introduction



- The field observation showed that the highest fractions of DGM were found at the highest marine DOM sites, suggesting increased reducible Hg(II) by marine DOM (Schartup et al., 2015).
- The lowest DGM fraction (7.8±2.4%) was observed in the near-coastal sites influenced by riverine inputs than the offshore sites. Significantly higher %DGM, observed in the ocean sites (15.8±3.9%), suggests that DOM may decrease reducible Hg(II) fraction or affect redox kinetics (Soerensen et al., 2013).
- The DOM composition is a critical driver of Hg redox reactivity and bioavailability in coastal waters, however, it's role has not been clearly identified.

Experimental Methods

1. Field Observations

Sep 2015 (6 sites)
Nov 2015 (6 sites)
Dec 2015 (8 sites)
Feb 2016 (8 sites)
Jun 2016 (7 sites)
Aug 2016 (8 sites)

2. Redox Incubations (June 2017, 6 am – 5 pm)

✓ Kinetic equations

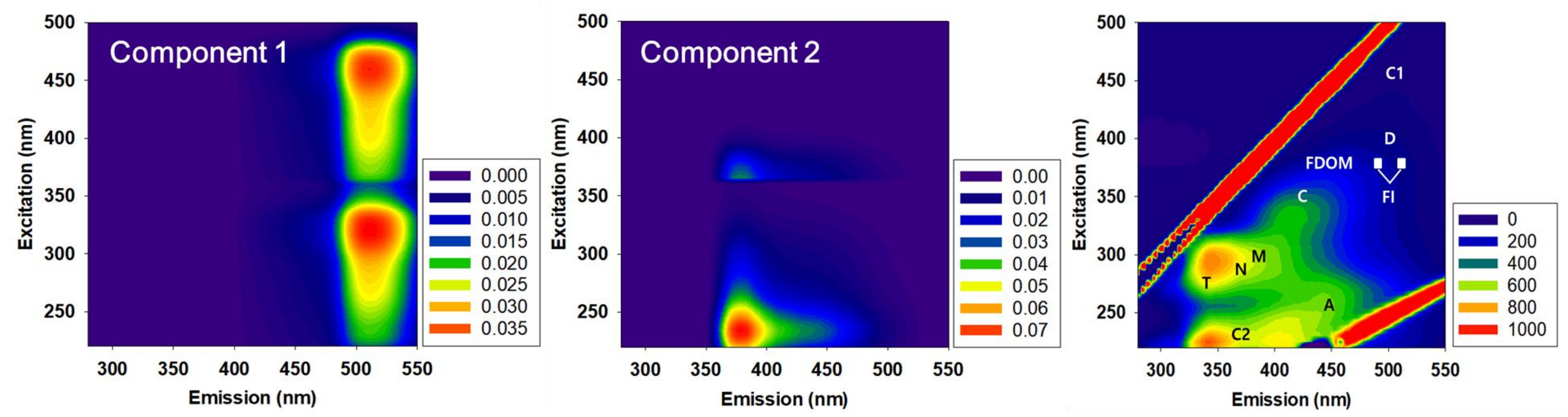
$$Hg(0) = Hg(0)_0 + [k_1 [Hg_{reducible}]_0/(k_1+k_2)] [1 - e^{-(k1+k2)x}]$$

$$a = k_1[Hg_{reducible}]_0/(k_1+k_2), \quad b = k_1+k_2$$

$$Hg(0) = Hg(0)_0 + a (1 - e^{-bx})$$

where k_1=reduction rate constant, k_2=oxidation rate constant, x=cumulative PAR (MJ m^{-2})

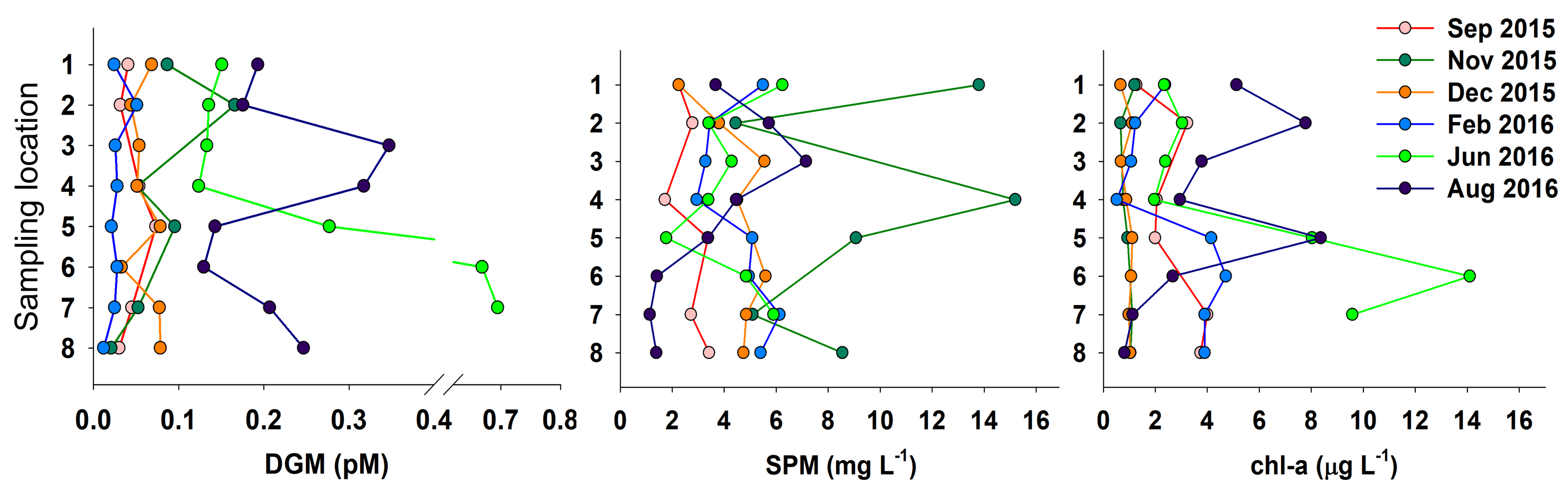
✓ Characterization of DOM by EEM fluorescence

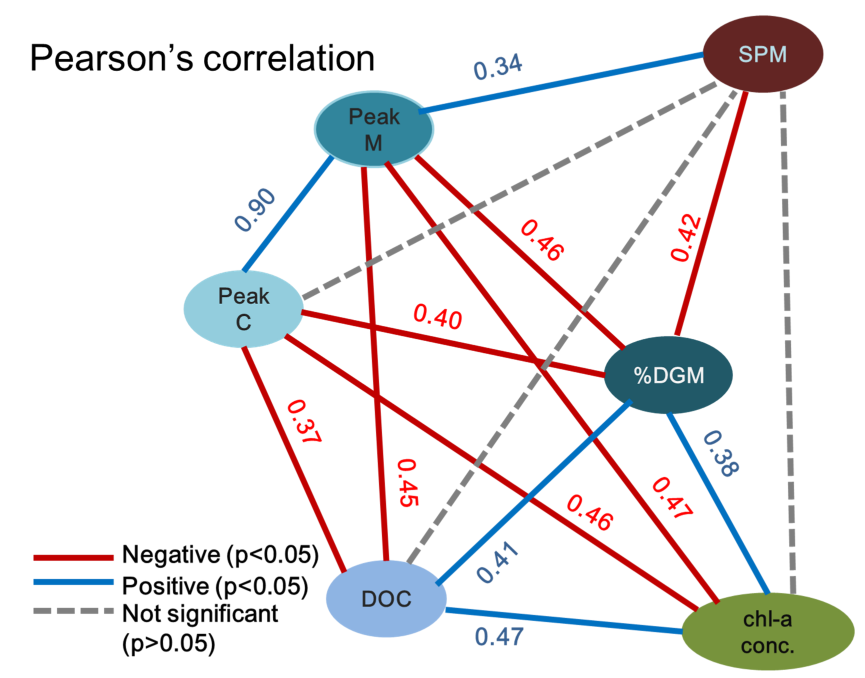


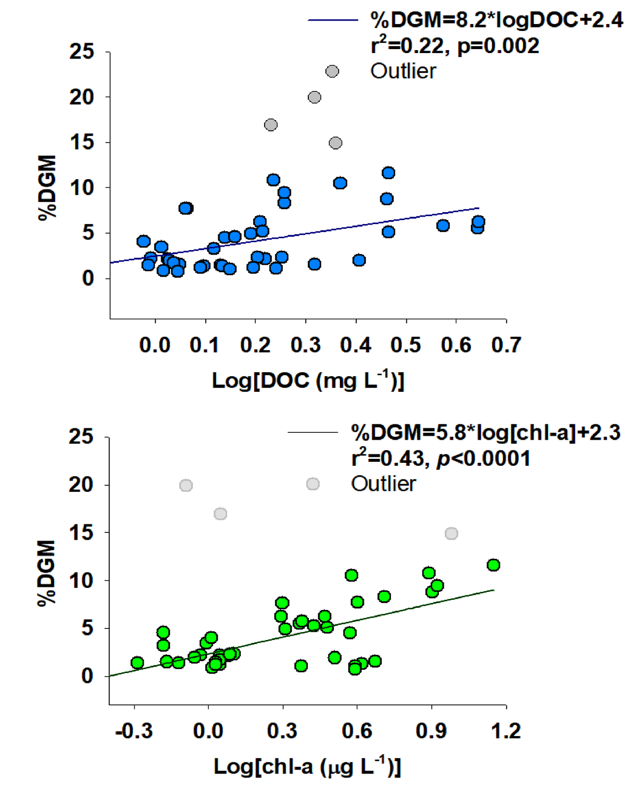
Peak	Ex_{max} (nm)	Em_{max} (nm)	Sources
C1	320 (460)	512	Microbial humic, terrestrial and marine humic,
C2	235	378	Terrestrial humic, large molecular size, hydrophobic, widespread
A	260	450	Humic-like
C	340	440	Humic-like
D	390	510	Soil fulvic-like
M	300	390	Marine-like
N	280	370	Algal derived
T	270	340	Protein-like
FDOM	370	460	Quinoid-like humic, in situ CDOM
FI	Em520 / Em480 at Ex370		Relative contribution of terrestrial and microbial sources

Results and Discussion

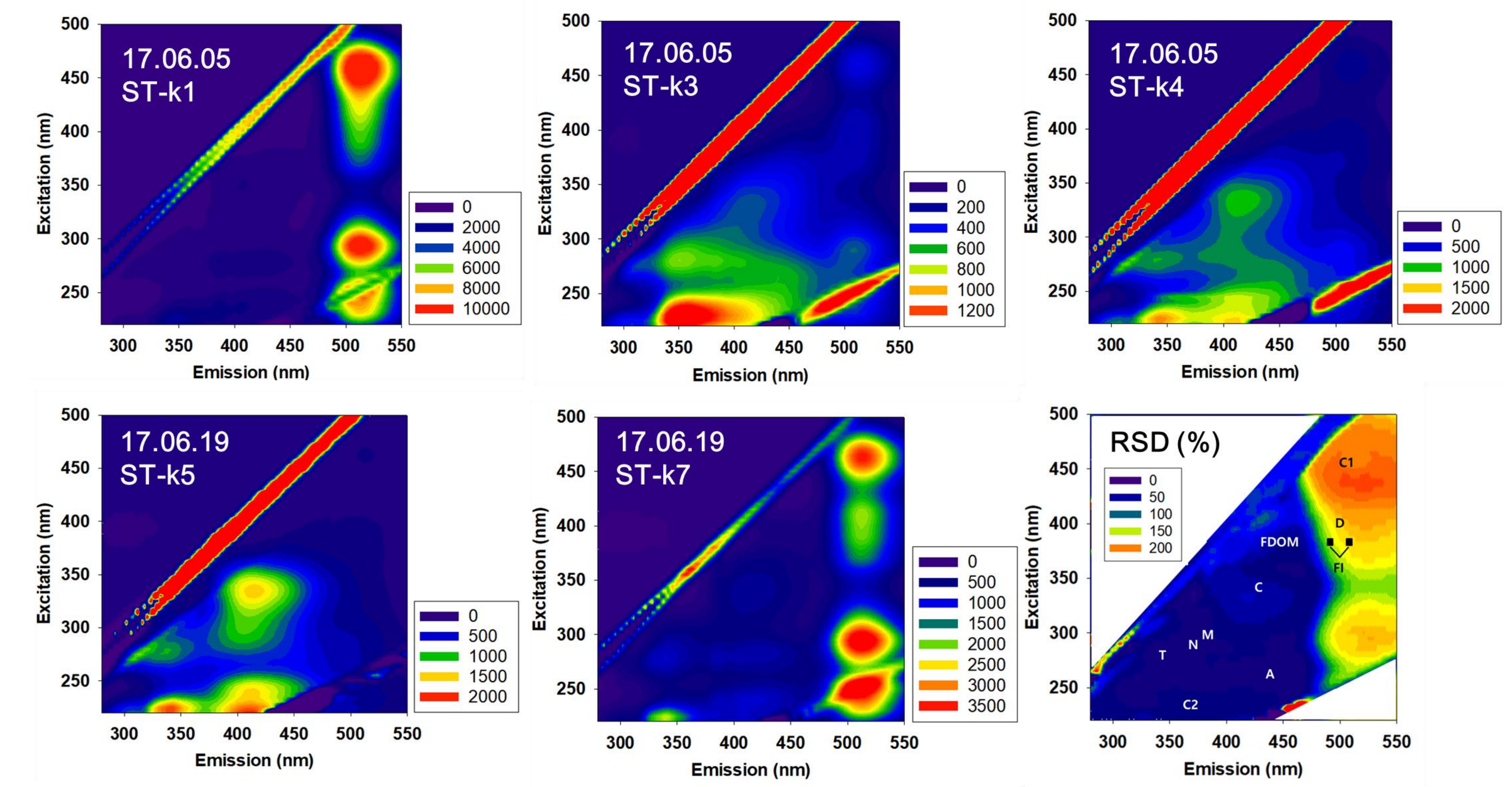
1. Field Observations



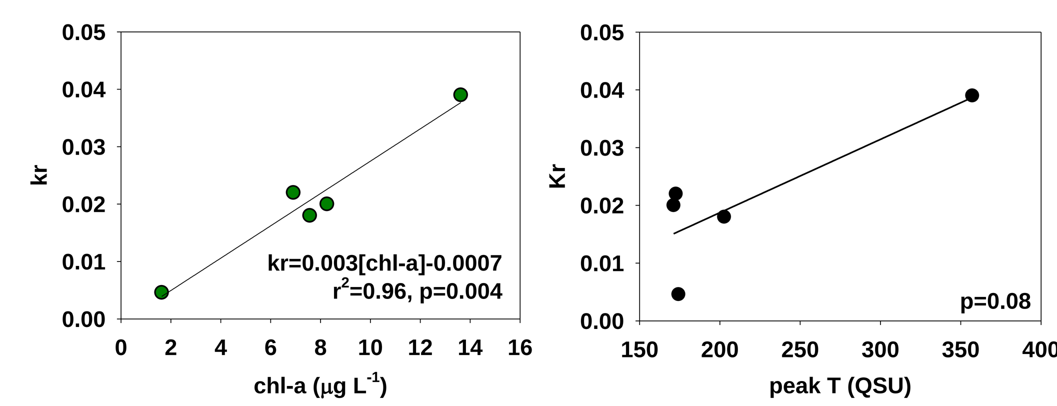




2. Redox Incubations



	Rate constant (m^2 MJ^{-1})	
	kr	ko
ST_k1	0.022	0.33
ST_k3	0.018	0.41
ST_k4	0.0046	0.16
ST_k5	0.039	1.0
ST_k7	0.020	0.59



- The DGM fraction of total Hg averaged 5.0% (0.13±0.15 pM) in the GY Bay surface waters. The %DGM showed significant positive correlations with DOC and chl-a concentrations.
- In the incubation study, Hg(II) reduction rate constant (kr) increased along with increases in phytoplankton biomass and peak T intensity.
- Algal-derived protein-like DOM may promote the reduction rate of Hg(II) in seawater. Currently, photo-bleaching experiments to identify redox sensitive DOM components are under progress.

Acknowledgements

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