Methylmercury Photodegradation Affected by the Presence of Organic Ligands

Y. Qian, B. Gu, B. Rao, L. Liang (Oak Ridge National Laboratory)

Photolytic degradation of methylmercury (MeHg) is a major sink in many surface waters although detailed rates and mechanisms of MeHg photodegradation are not well understood. In this study, we investigated the effects of organic matter on MeHg photodegradation by using different sources of naturally dissolved organic matter (DOM) and model organic ligands with various known molecular structures under both natural and simulated lighting conditions. We show that DOM and organic ligands all enhance photodegradation of MeHg under UV-A irradiation. The most significantly enhanced MeHg degradation was observed in the presence of aromatic thiols, such as thiosalicylate. Not only the sources and concentrations of DOM affected the degradation rates, but also the oxidation states of the DOM. The reduced DOM was three times more effective than the oxidized DOM in degrading MeHg, and we attribute this result to weakening the methyl-Hg bond by complexation of MeHg with thiolate ligands in DOM. Furthermore, we found that degradation rates were strongly correlated to light quality, with the irradiation of shorter wavelength much more effective than the longer wavelength. Under natural sunlight conditions, UV-A is the major driver, whereas visible light shows little influence on the photodegradation of MeHg. We collected fresh water samples from a contaminated creek for photodegradation study under nature daylight and observed a high MeHg degradation rate of up to $3.71*10^{-3}$ m^2 E^{-1}, which suggests that photodegradation could be an important sink for MeHg in this ecosystem.